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AMERICAN COMMERCIAL RELATIONS; A COMING INTERNATIONAL PROBLEM.

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In introducing Mr. Magee's article concluding his series in our February issue, we cited the significant fact that the leaders of the industrial world in America were already sounding a warning against the policy of extravagance with natural resources and indifference to outside markets. There can be no doubt that this conception will spread rapidly in the near future, and that action based upon it will materially modify the politics and policy of the United States, and thence the international relations between the New World and the Old. Mr. Oudin carries forward the discussion of this theme from the point where Mr. Magee left it, and he also writes with authority as well as with very great interest.—THE EDITORS.

A NATION'S war footing has always been held a fair indication of its rank as a power. In recent years it has become necessary to extend this proposition so as to include the idea that the magnitude of a nation's foreign trade is also in a way a gauge of its international rating. This modification of the original assumption is a natural one when we recognize that the prosperity of a highly organized and populous community is closely related to its activity in the commercial interchange of nations. Without prosperity in a body politic, the "sinews of war" will be lacking.

If not the existence of England's empire, certainly her continuance as one of the world powers depends upon her commercial supremacy. Deprive Germany of her continental and oversea trade, and the restless activity and ambitious designs of her Emperor would become as unimportant as they are now capable of bringing forth far-reaching results. It is an economic weakness of these countries that restriction of an already established foreign trade would produce dire finan-

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cial results. The profits from the internal trade alone, in the case of England, would be barely sufficient to keep her people from starvation, and in the case of Germany would not be sufficient to maintain her military and naval establishments and her great public works. The United States, on the other hand, would today suffer little in comparison with these two countries. Its domestic commerce is roughly estimated to be equal to the aggregate exports of the rest of the world. So small a proportion of the total volume of American business is foreign trade, that the latter may undergo a severe diminution without seriously affecting the financial situation of the country. This fortunate position of the United States will not last forever; Americans will find themselves, perhaps within this generation, facing (as European nations now do) the possibilities that result from the lack of a foreign trade.

It will be seen why one of the first duties of a Government is to favor, in every possible way, the growth of commerce. In the furtherance of this policy, diplomats have become in fact commercial agents, one of their chief missions being to safeguard the industrial welfare of their respective countries. Acting upon the generally accepted axiom that "trade follows the flag," territorial aggrandizement at the expense of weaker nations has been the consistent policy of most European powers. International disputes now have their foundation in commercial rivalries. Sentiment, traditional friendship, or the prejudice of centuries, may be forgotten over night, in the face of some great strategic position taken by a rival.

Home-seekers have given place to trade-seekers as pioneers of civilization. The portions of the globe habitable by the white races, for the most part are well settled. The westward progress of the farmers of the United States, resulting from the venturesome and restless spirit that produced the miracle of the peopling of the Great West, has long since ended. The Siberian frontier was obliterated at a still earlier date by the line of settlements stretching from the Ural Mountains east to the mouth of the Amur. The hardy grazers of Australia and of temperate South America, occupy most of the desirable land. These argonauts were conquerors of the wilderness for themselves and their children. The modern pioneer is no settler, no home-seeker. He is the engineering expert and promoter, and his field is the unknown, and often uncomfortable, quarters of the globe; those stretches of mountain, plain and forest, inhabited for the most part by inferior races. He is encouraged by his Government, and the knowledge of immunity of his plans from local dangers, has given him more heart and added to his audacity.

The far-reaching arm of a Government which encourages and fosters the commercial enterprise of its citizens, is represented by its consular system. This system had its beginning in the necessities arising out of the Oriental trade of the Italian cities. At first, a representative merchant was selected to decide disputes between members of the foreign colonies. The advantage of this practice became apparent to Governments, who assumed the right to make these selections. These officers became known as consuls, and were appointed to act in one another's dominions. With the growing importance of foreign trade, the legal jurisdiction was restricted, and today the most important duties of consuls are those which directly bear upon the advancement of the commercial welfare of their respective countries. Accordingly, a not unimportant duty of a consul is to report on the state and progress of manufactures, the requirements of the inhabitants of the country to which he is sent, the condition and extent of trade with other countries, and to make recommendations for diverting to his own country business going in other directions. The efficiency of a consular system as a whole is determined by the intelligence displayed in the reports of its consuls, and in the wisdom and practicability of their recommendations.

While today a diplomat's mission in its ultimate results is of a commercial character, it must not be overlooked that in the past he has been responsible for great treaties which have been totally without a political complexion. A commercial treaty with France was negotiated by Franklin in the second year of independence of the youthful American nation. A treaty with Holland, which followed a few years later, was of the same kind and was made possible by the cupidity of the merchants of Amsterdam, who hoped thereby to obtain a great share of American trade. The furtherance of commerce under the Confederation was impossible, as Congress had no power over commercial matters. The present Constitution was in part due to an appreciation of this lack of power. Commercial treaties have been negotiated by the United States with all the civilized countries. Early in its history as a nation, it inaugurated the policy of securing for its citizens the commercial benefits of the free navigation of rivers and seas. As a matter of international law, the United States first insisted that people who live along the upper waters of a river have a natural right to sail to the sea through the territory of other powers. We have made free to all, the navigation of the St. Lawrence, the River Platte, and the Amazon rivers in America. The principles of free navigation have also been applied to the Scheldt, the Rhine, and the Danube in Europe, and the Congo and the Nile in Africa. By

very reason of the policy not to engage in foreign alliances, America's formally contracted obligations with other powers have been for the most part commercial rather than political.

Such was the excuse, if any is needed, for the presence of the United States at the International Conference about Morocco. As one of the signatories of a convention with Morocco, held at Madrid over twenty-five years ago, it was bidden to attend the conference at Algeciras. The invitation was accepted as a right and as a duty, because one of the articles of that convention confirmed to all the Powers represented, the treatment accorded to the most favored nation. The protection of these commercial privileges, and not the political questions involved, was the object of American participation in the conference. The instructions of the Secretary of State to the delegates covered four points. The policing of the border country was to interest the United States solely in so far as it tended to ensure the open door for the commerce of all nations. The reform of the finances was to have absolutely no other interest than that the measures to be adopted should be such as not to interfere with equal rights for America to trade with Moroco. Private monopolies would be of interest, in that they tended to destroy the enjoyment of equal rights and their prevention was to be insisted upon, as was the suppression of smuggling because of its effect on the open door and on the prevention of orderly commercial relations.

A large part of the machinery of Governments, it will be noted, is working in the direction of making more effective the efforts of its citizens to market their productions abroad. The American Government has not been the least active in this respect. An inquiry into the results will, I think, lead us to the conclusion that the commercial advantages secured by their at times brilliant diplomacy, have not been fully utilized by American merchants and manufacturers.

The foreign trade of the United States is regarded by a large number of people with a certain mixture of indifference and pride—indifference, because of absorption in the vastly greater interests of the home markets, and pride that by the records only England has a larger foreign business. This indifference may also be ascribed to a certain provincial attitude of mind towards present conditions and a disregard of future necessities. Our pride as Americans is largely based on a general impression of our greatness as international traders that is hardly justified by the actual conditions.

The total foreign trade of the United States has more than doubled in twenty-five years. Month by month, the record of imports and exports is broken, and the crest of the wave does not seem to

have been reached. While recognizing the right to indulge in a vast deal of satisfaction with such an achievement, let us consider what right we of the United States have to be as elated as we are encouraged to be by an array of figures. Our European competitors are more interested in what and how much we sell, than in how much we buy from them and oversea countries. Our rivals use every means to combat our export trade, while considering it good business to encourage an increase in the other account. They are also as much interested in the kind, as well as in the amount, of American sales abroad; for the former, in a way, is a measure of America's position in the world's exchange. In fact, a country is largely respected and feared by its commercial rivals according to the extent of its international sales of manufactured goods.

During the past fiscal year, the exports from the United States were over one and one-half billions of dollars. Approximately two-thirds of this amount stands for the output of the soil, waters, mines, and forests—natural products. There is left the second great classification—manufactures—representing the most advanced of all articles which are the subject of barter and exchange. In their production, a man's physical effort finds its highest reward. An average workman, aided by automatic machinery, in one year will add one thousand dollars to the value of the raw material passing through his hands. A farm-hand ordinarily will not increase the wealth of the nation by one-quarter of this amount. The production of manufactures further requires the exercise of a man's highest faculties, and to dispose of them to his neighbor, demands in addition that they shall be better or cheaper than another's skill, brains, and ingenuity can make them. In the one-half billion dollars and more of these articles exported from the United States are included copper electrolytically purified and rolled, and refined mineral oils—"manufactured articles" by courtesy only. These two items comprise about thirty per cent of American manufactured exports. Thus analyzing the exports and reducing them to this basis, we find the United States on a lower level than England, Germany or France. England is so hopelessly ahead of us that we must leave her completely out of the category of rivals to be jealous of. Little Switzerland sets us a good example by her relatively large foreign sales. For every man, woman and child, she sends away in manufactured goods the value of six dollars per annum. This is ten times as much for each inhabitant as the corresponding export trade of the United States. If America were as active, her exports of this kind would be nearly four billion dollars, or as much as the foreign business in manufactures of the entire world.

It is not intended here to lessen in the remotest degree the importance and value of business in raw products. This trade brings to us in exchange the wealth of other nations in the form of money or commodities. These resources are not without end, however, at least they are not for always available for the export trade. Our American forests are disappearing. The output of our mines is being absorbed by ourselves in an increasing amount, year by year. Today our wheat supply is sufficiently large—even bountifully so—to feed our people. In another generation, when the population of the United States will be twice what it is today, the great outflow may cease and an opposite current may set in, through the inability of the country to supply its own needs. This part of our trade cannot be considered permanent. It is upon our exports of manufactures, then, that ultimately we, in common with other nations, must depend for our real position in the the Parliament of Powers. When we reach a point in our development where we absorb our own natural productions, we will be forced in order to maintain our prestige, to become what we are not now—adepts in the foreign trade.

For the present, America's exports of natural products pay for the purchase of the manufactures of other nations to the extent of nearly one billion dollars, and she enjoys the respect to which magnificent extravagance is entitled. An unusual prosperity, a high standard of living, and a seemingly insatiable desire for luxuries, as well as a present condition of need, have created the enormous demand. Herein lies a certain immunity from foreign wars. Our rivals are too greedy for our trade to jeopardize it by wanton attacks. By reason of its basis, our foreign purchase account is sensitive, and our custom precarious. In hard times, we buy as little as we can. Unlike England, who is dependent upon the outside world for her supply of food and for raw and for partly manufactured materials to keep her mills and factories running, we raise all we need to eat, and could, if we were hard put to it, make almost all the things we import.

An American Consul, replying to the question as to what was the greatest need of the American manufacturer, said that it was to convince himself that he actually wanted to seek foreign business. This idea has been put rather more strongly by the financial correspondent of the London Times, who has this to say:

> "The truth is that foreign trade in any way is now beyond the knowledge of American people. I was almost tempted to say that it is beyond their desire and intentions. That in an indefinite way they would like to have a foreign trade is perhaps true, but for the reason that they have been so long accustomed to look to the home market, it is impossible for them to take the steps that would give them any considerable show in foreign markets. After all, Americans are the most conservative people in the

> world so far as outside conditions are concerned, and so where these are involved they are content to go on doing a foreign trade that is merely complementary to the home trade."

This general attitude of indifference to the extension of commerce, and the conservatism of American bankers and merchants toward outside affairs, is strikingly shown by the failure to comply with certain requisites for the development of this trade, which involve no great risk or inconvenience. These are the establishment of foreign banks and of steamship lines of American ownership, and the granting of more or less extended credits. Among other handicaps to the increase of American business abroad, may be mentioned actual ignorance of geography and of postal rates, bad packing, disregard of shipping instructions, of customs regulations, and indifference to the tastes and peculiar requirements of a people whose trade is sought.

The methods of American manufacturers engaged in the foreign trade have been described as very crude in comparison with those employed by their European competitors. Indeed, we have not emerged from the kindergarten class. It is exasperating to our customers to have to pay short postage on letters from America. The superficial knowledge of our office and mailing boys, and a reflection on their superiors, is shown in the constant misdirection of letters. The disregard of customers' instructions and of customers' regulations is a special complaint against American shippers. The regulations of Spanish-American countries are specific and rigid, and failure to comply with them in every respect involves a fine. A severe and perfectly just criticism is made of our careless and improper method of packing. We should copy the Europeans in this matter. There is no scarcity of wood and nails in the United States, but of knowledge and of interest as to the quantity necessary to insure the safe arrival of the goods at their destination. A case that is only strong enough for carriage by box car is no protection for goods shipped half round the world, handled many times, and perhaps buried beneath tons of cargo.

We should also follow the lead of our chief competitors in catering to the tastes and wishes of foreign customers, and in studying their national traits. Every nation has prejudices and peculiar requirements that to unthinking people may be considered absurd. The Chinese have shown a fondness for talking machines. A certain make of phonograph was offered for sale, having as a trademark a picture of the machine and a listening dog. The trademark or "chop" was considered undignified and of doubtful propriety, because of the connection—obvious in the Chinaman's mind—of a dog with a human audience. The substitution of an aged Chinaman for the dog removed the ban of unpopularity.

The value of cheap and direct transportation to foreign markets in building up outside trade has been disregarded by the United States Government. That it does not employ the methods of European Governments, who regard the protection and extension of their commerce as of first importance, is mainly due to party politics, assisted by the prejudices of the inland representatives. The necessity of aiding the merchant marine is so obvious as hardly to admit of argument. The great trade of England and of Germany owes a large measure of its success to Government subsidies in one form or another. This assistance has made possible the establishment of the many steamship lines intersecting the oceans highways, and uniting every important port of the commercial world with their own maritime centers.

At the beginning of the Civil War, American ships carried 65 per cent of the foreign commerce of the country. Forty-five years later they were carrying less than 8 per cent of it. To such a low ebb have we come that during 1903, not an American ship entered or cleared from a single port in Austria, Denmark, Germany, Greece, Italy, Netherlands, Norway, Russia, Sweden or Turkey. In June, 1904, not a vessel flying the American flag passed through the Suez Canal.

During seven years, the United States Army and Navy cost about one billion dollars. A small percentage of this sum devoted to the upbuilding of the merchant marine would enable American citizens in due time to retain in the country a large part of the two-hundred million dollars annually paid foreign ship-owners.

The importance of cheap and direct transportation to any market diligently sought is shown by the extraordinary increase of American business with Turkey after the establishment of monthly sailings direct from New York. American products prior to 1899 were carried 6,000 or 7,000 miles in a roundabout route. England, Germany, Austria, and Italy controlled the carrying trade and pre-empted the Turkish market. Competition with the American ships reduced freight rates one-half. The result was that exports from the United States to Turkey in 1897 must be multiplied thirteen fold to arrive at our exports in 1902. That the growth was due to direct service is shown by the absence of any gain at ports not touched by the direct service.

Among other handicaps to the extension of trade are a high protective tariff and the influences of trade unions. The high tariff on imports certainly operates against building up a large and lasting market for export products. It makes high prices at home, and be-

cause of the increased cost of production, it keeps them high abroad and prevents successful competition. The aim of all labor organizations is to multiply the number of workmen by reducing the number of working hours. This tends to increase the cost of labor. Countries not so dominated by the labor element have the advantage in the struggle for an outlet for their productions. The United States can not indefinitely indulge in both these policies in their present extreme tendencies, and hope for ultimate success in capturing foreign trade. Whether the good to be gained would justify a change in economic policy, or a more decisive stand against the unreasonable encroachments of organized labor, is open to discussion. We should, for the sake of a better understanding of the future possibilities of foreign trade, have always clearly before us the incontrovertible fact that both these conditions are absolutely incompatible with supremacy in our commercial relations.

Despite the handicaps referred to, American activity abroad is increasing. As a result, the cry of the American Peril has been made familiar by frequent reiteration in Continental news items. This invasion of European markets has stirred up a number of Chancelleries, it is said, to the point of proposing concerted action against the danger. Many believe America has earned this resentment. But, what are the facts? Let us consider the case of Germany. Last year she sold us over one hundred and fifteen million dollars worth of her manufacturers, and in return took not quite fifteen million. It does not affect the argument that we sold her in addition, over two hundred million of our natural products, chiefly cotton, raw materials, and provisions—products which she is obliged to buy of us for the most part, and which we would sell to other countries if she did not take them. It is due to the appreciation of this situation by German manufacturers, that in spite of the agrarian opposition, that country having much to lose and little to gain, has receded from her threat of a tariff war. She has postponed for one year, as far as the United States is concerned, the operation of her new system of tariff relations.

The fact that sewing-machines, typewriters and machine tools could successfully compete with the home-made articles, in spite of a heavy tariff, has aroused Germany to a consideration of the future possibilities of American export trade. The German manufacturer, keen, critical, far-sighted, and adaptive, well knows that today American attempts at securing foreign trade are, in general, haphazard and unscientific. Most German manufacturers export from 50 to 75 per cent, or even more, of their total product. In one district, de-

voted to porcelain making, 80 per cent of the output is exported. The foreign business of Germany is vital to her existence, and, therefore, is the solicitous object and constant concern of the entire nation. Her manufacturers are alarmed at what may happen. It was to be expected that they would come over to examine and investigate the United States. They have been admitted to American offices and workshops, where they have made a study of industrial conditions for the purpose of ascertaining the strong and the weak points. They have strengthened their position in the struggle for foreign trade—a struggle in which we are one of the principals. The question arises —are we wise and can we afford to disclose to our rivals, to the extent we have in the past, our processes, our industrial and factory management, and our trade secrets?

Confronted by an intelligence not less keen than ours, handicapped by labor costing us from 75 per cent to 100 per cent more, competing with a spirit of enterprise no less audacious, and distanced by an organization marvellously effective for the development of foreign trade, how are we going to come out in the forthcoming struggle for place in the world's trade? Without now considering the question of supremacy, I would say that our salvation from defeat lies in that inborn and native quality of mind, ingenuity and inventive skill. The German manufacturer is not far behind us in originality and in addition is a good copyist. In an incredibly short time after the appearance of an article that has a wide popularity, he will offer for sale a clever imitation of it. To offset his lower price, the American manufacturer must lower the cost of manufacturing, or improve the article. That improvement, the German again will copy. We are an appreciable time ahead of him in some lines of production, thanks to the ceaseless exercise of those qualities before mentioned. For example, our originality and initiative find expression in the graceful design of our shoes, the mechanical superiority of our machine tools, sewing-machines, and a score of devices, and not least in the application of ways and means to the cheap making of these and all other articles.

By so much as we make confidants of our rivals, we tend to eliminate the time element which is in our favor, thereby narrowing the distance between us and defeat.

We have much to learn from the Old World manufacturers, but not, I think, so much as we can teach them of the art of manufacturing, pure and simple. To get to know our competitors and to appreciate their good qualities, is to relieve competition of some of its harsher aspects. Their unsurpassed methods of extending foreign

business and their older sciences can be acquired, and the good points of their supremely excellent systems of education, civil government and management of public utilities, can be adapted to our conditions, without parting with one of our greatest commercial assets.

During the past few years, a swarm of European engineers, scientists, merchants, and manufacturers have inspected minutely and intelligently our industrial and commercial establishments. The Germans have come in larger numbers than any other nation. They have returned filled with enthusiasm at our hospitality and liberality. Their note-books likewise have been filled, and our tools, our designs and manufacturing processes have been adopted with celerity and discrimination worthy of the Japanese. Our commercial methods and our corporation management do not seem to have appealed to them. Our lukewarm efforts at seeking foreign business have removed their fear of the bogey of the "American Peril." The reports of these gentlemen afford an excellent opportunity of seeing ourselves as others see us. The impression of American industrial conditions obtained by these trained observers, has been summarized by our Consul General Mason, formerly of Berlin, now filling the same post at Paris. The reports of these visitors to their local associations, as far as published, almost universally admit the great resources of our country, the mechanical skill of our people, the superiority of our rail transportation, and the progressive spirit always seeking a better machine or a better method than the one in use.

These critics have noticed in us a general feeling of complacent satisfaction with everything American, a conviction that what is done or produced is the best. They have noticed an ignorance and an indifference about everything outside of the United States. They have laid emphasis on the meagreness of technical information, and the trifling annual contingent of chemists, engineers, educated dyers, weavers, and electricians, as compared with the throng of lawyers, physicians, dentists, and unspecialized graduates. Continuing, to use Mr. Mason's words:—

> "But most surprising of all appeared to the German visitors the absence of any adequate system of special education for commerce, banking, and foreign trade. Reduced to simplest terms, these investigators generally conclude that the reliance on a general and more or less superficial education, together with natural adaptibility, to fit young men for almost every walk in life, and of specialized study in physical science, modern languages, and the industrial arts, will, if persisted in, neutralize much of the advantage which our country enjoys through natural resources and advantageous geographical position for the South American, Mexican and Asiatic trade."

While we may not agree with all these observations, those who have considered the matter will be inclined to admit that the surface

conditions affecting the export situation are as described by these gentlemen, and that if no important factors have been overlooked, the forecast of the immediate future in that field is tolerably accurate. If these critics have made any mistake, it has been in overestimating the disadvantage of the lack of specialized training and of attention to details not always essential, though desirable, and in underestimating the value of certain national characteristics. They have missed the point that systems of education are valuable chiefly to the extent to which they create independence of thought and a high average of intelligence. They have not attached sufficient importance to inventive and mechanical skill. Thay are not aware that by reason of American freedom from Old World setting and inflexible social conditions, a national characteristic is the fresh mental grasp of great problems, resulting eventually in doing a thing in the best possible way, time and circumstances considered. Finally, there is our adaptability to new conditions, which has its special manifestation in the readiness to make sacrifices for a principle.

When the day arrives on when America feels the imperative necessity for an outlet for manufactures, it will find us ready to confess our ignorance and unpreparedness and by every means within our power to undertake the herculean task of overtaking our successful rivals, even to the extent of sacrificing a cherished domestic policy, or of asserting our legislative independence of demagoguery and other unworthy influences. By that time what will be our commercial and political relations with our European competitors? The question as to what these relations will be when the United States seriously encroaches upon the foreign trade of the world cannot be ignored. The effect on our Continental rivals of our present small successes, does not argue well for our future relations with those countries. As closer acquaintance engenders friendly relations and tends to remove misunderstanding, rancor, and mutual dread, let us do our part by encouraging the study of one another's social and economic conditions.

The answer to the question offered for consideration must be left to the future, when the bloodless but formidable struggle begins for place in the share in the world's commerce—to that time when America asserts her claim to the position to which she is entitled; because standing for what she does before the world, she cannot then remain stationary.

THE PROPOSAL TO FORCE THE USE OF THE METRIC SYSTEM.

By H. H. Suplee.

The manufacturers of the United States are just beginning to realize that there is now in Congress a concerted attempt, originating it is believed in the Bureau of Standards, and vigorously seconded by the Chairman of the House Committee on Coinage, Weights, and Measures, to secure the enactment of legislation leading to the compulsory adoption of the metric system of weights and measures in all departments of the Government, and thence into the entire country.

It is believed that such meddling paternalism needs only to be widely known to be effectively checked, and hence it is here brought to the attention of those most nearly concerned, in order to arouse them to that vigilance which is the price of liberty.—THE EDITORS.

FOR more than ten years there has been an active propaganda going on to secure the enactment, both in the United States and in Great Britain, of such legislation as shall aid in the introduction of the metric system of weights and measures into English-speaking countries. Bills have been introduced into Congress and into Parliament looking to this end, and although no laws have been enacted over those which, many years ago, legalized the system, the advocates of compulsory legislation have persevered, with a determination worthy of a better cause, and will doubtless continue to persevere until convinced of the hopelessness of the attempt.

At the present time there is, in the House Committee on Coinage, Weights, and Measures of the United States Congress, the following bill, entitled:—"A Bill to Fix the Standard of Weights and Measures by the Adoption of the Metric System of Weights and Measures.

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after the first of July, nineteen hundred and eight, all of the Departments of the Government of the United States, in the transaction of business requiring the use of weight and measurement, shall employ and use the weights and measures of the metric system."

The chairman of the committee has been most desirous of making it appear that this bill is altogether harmless, and that it means nothing to the manufacturer, engineer, or machinist, since it applies apparently only to the departments of the Government, and to those who have business dealings with these departments. The sponsor of the bill, however, Hon. Lucius N. Littauer, known very widely as a

manufacturer of gloves, has made the following statement in his testimony regarding the bill: "It is meant to be, and I hope that it will be, the entering wedge towards the adoption of the system generally."

The chairman of the committee, with a disrespect towards the United States Government, which, it is hoped does not extend to his constituents, referred to the Government as a dog, and stated, before the American Society of Mechanical Engineers, that the bill was intended to be for the purpose of "trying it on the dog," in the hope that if the Government departments could stand it, the Congress might be encouraged to further compulsory legislation and try it on the public. He refrained from mentioning the particular animal which he would select in designating the aforesaid public—probably an animal with long ears and a patient disposition, as it well might be if it submitted to such experiments.

It is time for plain speaking about this persistent attempt of certain politicians, themselves utterly ignorant of the conditions of American manufacturing industries, to enact compulsory legislation which has not been demanded by any one who has anything to lose.

Briefly, the argument for the metric system may be reduced to three counts—the greater simplicity of the tables of weights and measures; the precise inter-relation of the units of length, dry and liquid measure, and weight; and the convenience of the decimal system of notation.

The last is already practically secured in the English-speaking countries, by the general use in all engineering work of the decimal divisions of the inch or the foot; these units of themselves are even more convenient than the metre or the centimetre. The second supposed advantage exists only in the case of one medium—distilled water at 4 degrees centigrade—a substance with which no one, except possibly the laboratory experimenter, ever has to do. The third may be admitted, though with the qualification that much of the intricacy and multiplicity of the old English system of weights and measures has already disappeared, and a further wholly practical simplification might be made without uprooting the standards upon which our gigantic industries have been built.

It must be remembered that when France and Germany adopted the metric system this vast growth of machinery and tool-building industries, of structural-material manufactures, and of metal trades generally, had not come into being. Standardization was as yet an unknown idea. There was practically nothing to undo, except some

simple habits of barter and trade, before the new standards were taken into use.

The situation in the United States and Great Britain today is absolutely different. Industries such as the world has never before seen have been built up, and have sent their products all over the world. And every steel section rolled, every plate turned out, and every wire drawn, every engine and dynamo and machine tool, every pipe and shaft and bolt and nut, is based upon the inch and the foot—units wholly incommensurable with the metric ones. The screw-threads of England and America are standard all over the world—and they are wholly inconvertible into any metric expression which could be used as a guide or practically reproduced by a workman. If all these measurements must be changed into metric equivalents, the *things* themselves must be changed; to believe that we could go on making them as they are now, and gauging them by the new system of measurement, is to cherish a mischievous delusion. It is not conceivable, for example, that any shop should continue, as a regular daily routine, to turn or bore work accurately to such a dimension as "25.40001 millimetres," (the metric equivalent of one inch), or to cut bolt threads on a pitch of "8.466 threads to 25,40001 millimetres" (the metric equivalent of the Whitworth standard for one-inch bolts); it is not conceivable that such standards could continue in use in specifications. We should inevitably be forced to change to integral measurements—25 millimetres, perhaps, and 8 or 8½ threads. And a similar condition would arise throughout almost the entire range of mechanical construction. Every part now standardized to decimals of an inch would have to be redesigned to commensurable decimals of a centimetre. Then the new and old would not interchange. All the old machines and all the old repair parts would become bastard. The years of earnest and costly effort, and the millions of dollars spent to secure interchangeability and standardization, would be wrecked and marked for the scrap heap by the first compulsory legislation enforcing the use of the metric system upon our manufacturers. And it would take more than fifty years of endless confusion and double-standard working to clear the deplorable and expensive wreckage out of our shops.

Let us leave generalities for a moment and listen to the men who are vitally interested and who have appeared before the committee to try to make its members listen to reason.

When the late Mr. William Sellers, the dean of the machine-tool industry in the United States, and one of the most eminent engineers

on either side of the Atlantic, appeared before this committee, one of its members actually had the courage of his ignorance, and asked Mr. Sellers what was the character of his business, and what kind of tools he made! And when Mr. Sellers tried to explain to this eminent body of legislators what everybody else in the country competent to judge knew already, he was practically snubbed by another member of this intelligent assemblage and called upon to explain that he was really competent to say something upon the question. Finally Mr. Sellers was permitted to say what American manufacturers fully endorse: "The proposition to change our system for the sole object of conformity with a system which has not even been accepted in metric countries, is absurd, and could only emanate from men utterly ignorant of the conditions required, and of the necessary apparatus to fulfil them."

Another American manufacturer, one who has held the position of president of the American Society of Mechanical Engineers, Mr. Henry R. Towne, well-known both in the United States and in Europe as an eminent engineer and scientist, touched upon another side of the subject. It has been claimed that the adoption of the metric system by the United States would add greatly to its opportunities in connection with export trade to metric-using countries. Says Mr. Towne: "In the judgment of the great majority of those who are concerned in the export trade in manufactured products, the abandonment of our present standard for the French standard of length would not only be of no benefit to us, but would impose a serious handicap upon us." Mr. Towne emphasized the most important feature of the subject when he stated that to make the change from the present system would cost the manufacturers of the United States from $500,000,000 to $1,000,000,000 to replace their gauges and standards alone. It is most significant that the bill is opposed by every manufacturer who has capital invested in tools and manufacturing appliances, and that its only advocates are those who have not a dollar at stake, and who care nothing for the investments of the men whose industry makes their positions possible. Broadly, the position was most clearly stated by Mr. Towne, when he said that other nations had adopted the metric system in the hope of attaining a uniformity which the English-speaking nations have already, and which they should never be compelled to cast away, either in their Government departments or in general by any form of legislation.

Another man whose opinions will be conceded as having some weight in connection with the liberty of American engineers as to

the system of weights and measures to be used with them in dealings with their own Government and with each other is Mr. William Lodge, one of the leading machine-tool builders of America. Referring to the American system of making standard gauges, templates, jigs, and similar tools, and locking up immense amounts of money in such appliances in them in order to permit the manufacture of standard appliances in tools, Mr. Lodge said: "The mere fact of the American manufacturer giving his attention to the standardizing of his products, and making it possible for him to ship them anywhere in the world and send duplicates of parts, should in itself be a sufficient argument to those handling the question not to upset all this and put such men as us out of business."

Another witness to whose testimony respect should certainly be given is Mr. Walter M. McFarland, acting vice-president of the Westinghouse Electrical and Manufacturing Company, who testified before the committee that it would cost his company $500,000 to make the necessary changes in their gauges, jigs, templates, and drawings.

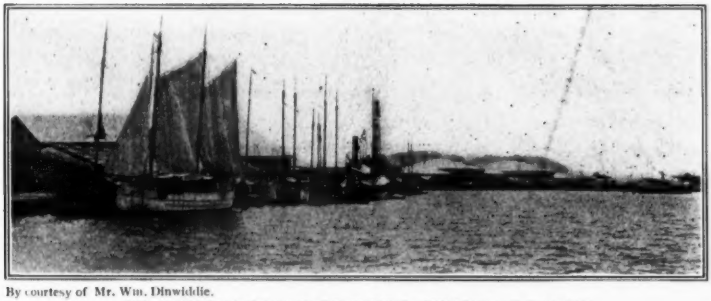
It has often been said that the electrical engineers and manufacturers are in favor of the change, and there is no doubt that, so far as computations are concerned, many of the electrical engineers favor the metric system. This is the more easy on their part because it would be their employers and not themselves who would have to foot the bills. As a matter of fact, all the electrical machinery in the United States and Great Britain is built upon the existing system of measures, all dimensions being based upon the inch, and no metric dimensions entering into the completed machinery.

Many arguments have been made upon the subject of the textile industries, and it is most interesting to note that the presence on the committee of an expert in the textile manufacture has done much to confound the ignorance of some of the so-called textile experts who have been called in favor of the bill. As a matter of fact it has been shown, by overwhelming testimony, that so far as the internal organization of textile fabrics is concerned, the inch is the standard in Germany and France as it is in England and in the United States, this being undoubtedly due to the fact that the early predominance of Great Britain in the textile industries caused the British system to become so thoroughly rooted in all textile districts that it has not been found practicable to uproot it.

It must be clearly understood that we have no direct quarrel with the metric system as such. It has its merits and its defects, as every system must have. The real quarrel of the American and British

engineer and manufacturer is with those who would, by means of any legislation, direct or implied, deprive him of the liberty of using whichever system he finds best adapted to his needs. Many men may find a decimal system more convenient for computation, using either the metric system or the British system decimally subdivided. Others prefer the method of continual bisection, this having been found pre-eminently convenient in the workshop and for details on construction generally. Since 1866 the citizens of the United States, whether holding Government positions or engaged in civil industries, have had the privilege of using either system legally and freely. In no case have the friends of the inch attempted to impose their views upon the advocates of the metre. Live and let live has been their rule of conduct, a rule which appears to have chafed severely upon those who prefer to count on their fingers rather than with their minds. If the advocates of the existing standards should endeavor to influence legislation to prevent their neighbors from using their beloved millimetres and kilogrammes, a fearful howl would arise; but no such impertinent interference is to be dreamed of. Let the advocates of the metre be fair-minded enough to give up their scheme of stacking the cards; let there be a square deal, and may the best system win.

But let the gentlemen at Washington have a care. The American citizen is patient, but the proverb about the anger of a patient man should not be altogether forgotten. If this pernicious and meddlesome paternalism is not dropped, and if the disposition to enact some sort of compulsory metric legislation is not abandoned, there is but one thing to be expected. The engineers and manufacturers of the United States and of Great Britain are not to be trifled with. The campaign will be carried into the technical press, into committee, on the floors of both houses of legislation, and especially among the constituents of the men who are short-sighted enough to persist, and the question will not be settled until it is settled right.



By courtesy of Mr. Wm. Dinwiddie.

THE INNER HARBOR OF ILOILO, ISLAND OF PANAY.

TRANSPORTATION IN THE PHILIPPINES.

By Lawrence E. Bennett.

Mr. Bennett is an engineer of high standing and long experience in the Orient, whose services were some time ago requisitioned by Governor Taft for the outlining of the plans of the Insular Government in providing transportation systems in the Philippines. The measures proposed have recently received a strong impetus through the assumption, by the White Syndicate, of New York, of the responsibility for building and operating three main lines in the Visayan Group. Their estimate, amounting to $11,500,000, was based largely upon the results of Mr. Bennett's reconnaissance and report, and he will remain with the enterprise as construction superintendent and assist in getting the new project under way during the coming summer. The thanks of the Magazine are expressed to Wm. Dinwiddie, Esq., late provincial governor of Lepanto-Bontoc, for many of the illustrations accompanying Mr. Bennett's article.—THE EDITORS.

THE Twentieth Century, at its very beginning, has afforded strong indications of what it will ultimately show in the way of change in the commercial relations of the world. It has been ushered in by a great and sanguinary conflict, as one result of which the Far East has become at once the cynosure of universal attention. Much of this attention has been of an evanescent nature, but there is a deeper and more lasting significance attached. While the interest has been generally a manifestation of the modern craving for sensation, careful observers of economic conditions and progress have watched rather for the reason that the *casus belli* involved the destiny of the Middle Kingdom, and the whole future of trade in the Orient. The yellow man and the white were combating for the establishment of commercial and territorial precedence in one of the most alluring of the unexploited regions of the world.

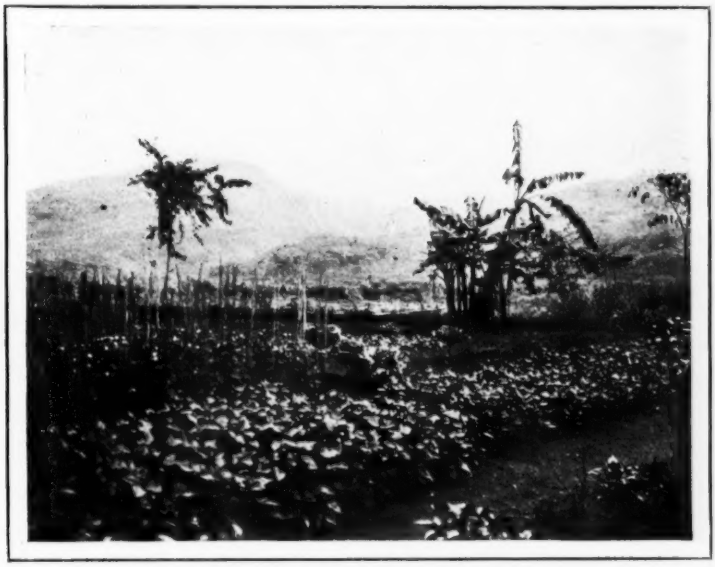
LOOKING UP THE PASIG RIVER FROM THE OLD WALL OF MANILA, BELOW THE BRIDGE OF SPAIN.

The immediate result of the Russo-Japanese war has been settled now for nearly a year, but the attention of the thinking West is apparently held as firmly as ever in the East, awaiting answer to the question of what use Japan will make of her new-found prestige. The resurrection of her great, sleeping neighbor, now comparatively imminent, is fraught with the profoundest interest for the Japanese nation. The opportunities of further progress for Japan lie in China chiefly, and this brings her face to face with the real and assumed rights and the scheme of the great western powers, important among whom now, as the result of territorial expansion and commercial interest, must be numbered the United States.

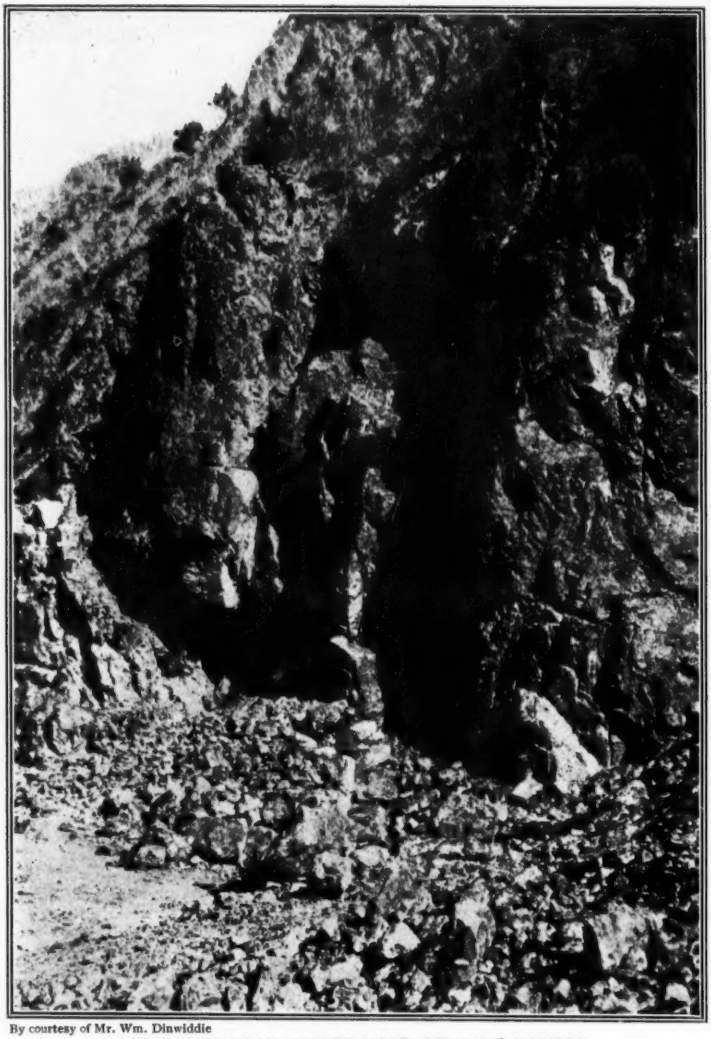
It would seem that territorial aggression in China by the western powers has been removed from the field of probability, and there has been substituted the saner economic question of the maintenance of trade rights. Because of the tremendous resources of the Chinese Empire, the beginning of the development of which but awaits the turning of a card; because of the peculiar stimulus being applied to keep alive the boycott against American goods; and because she is irrevocably bound up in the destiny of the East through possession of the Philippines, the United States must bend her energies upon the firm establishment of an oriental prestige, political and commercial. The time is the present. The future will show this to have been the inception of the psychological period, as it were, in the regeneration of China. Vacillation between such extremes as are indicated, upon the one hand, by the restitution of a justly exacted

indemnity, and, on the other hand, by arrogant threats of military invasion, cannot avail the United States in China; for, with all his national weakness, the Chinaman is among the quickest to take advantage of uncertainty in another. Amicable understanding is dependent upon a just and decent administration of the Exclusion Laws, and upon a healthy trade relation.

Among the ways and means of attaining a mutually beneficent trade connection is the development, without delay, of the resources of the Philippine Islands. Thus far, Washington has been intent almost solely upon the solution of the problem of a satisfactory government for the Filipinos, and it is a problem deserving of the best thought that can be brought to bear. But the matter of making the Philippine Islands the paying investment that they ought to be, should not further suffer the neglect to which it has been subject. There is no logical reason why the two problems may not be treated in parallel. There is no conflict. To foreigners experienced in colonial administration, I have found that it is a matter of manifest surprise, not unmixed with derision, that the United States has so far allowed the Philippines to remain a drain on the national exchequer, without concerted effort to develop their resources.



A TRUCK FARM IN THE PHILIPPINES.



By courtesy of Mr. Wm. Dinwiddie

THE MANCAYAN COPPER MINE, LEPANTO-BONTOC.

Showing a massive exposure of ore.

Congress has shown a peculiar apathy towards the necessity of encouraging the Filipinos in the cultivation of their own natural resources—notably sugar. At the present time China furnishes a market for all of the sugar grown in the islands, and, in view of her impending regeneration, may be expected in the future to provide a demand for Philippine sugar beyond the utmost capacity of

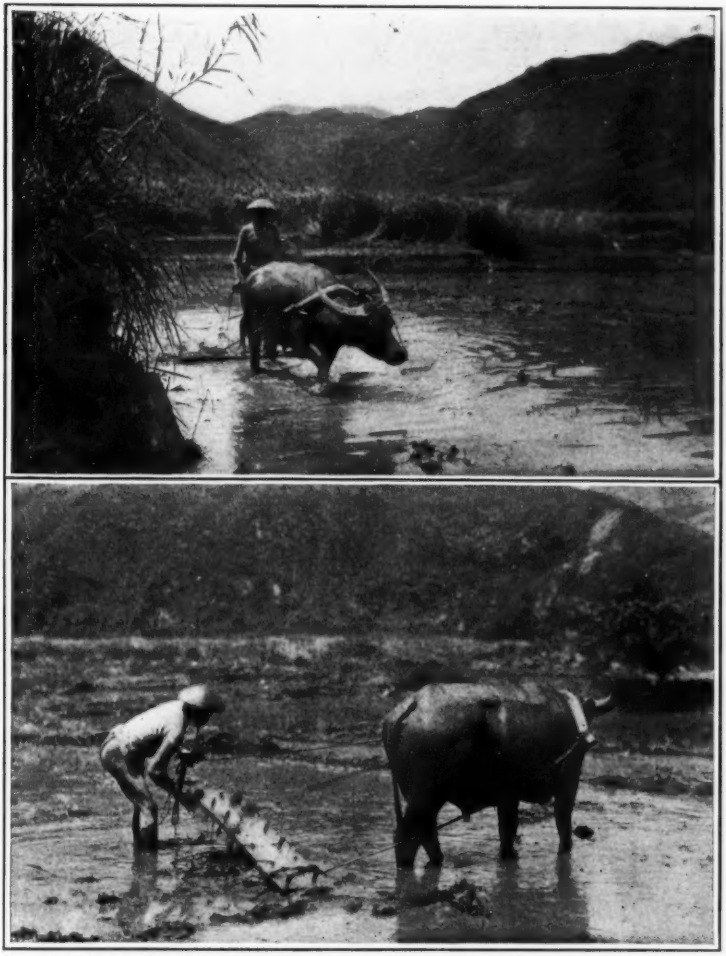
PRIMITIVE MINERAL INDUSTRY.
Igorrote panning gold in a pan made from the bark of a tree.

the Philippines to supply. So, while the production of the islands is susceptible of a marvellous expansion, it is not likely that American sugar producers will ever be compelled to meet the competition of the colonial product in their present markets. For years, even the carrying trade between the islands and China has been practically monopolized by Chinese merchants, who eagerly buy up the produce of the Philippine plantations for shipment, right in domestic markets. This is particularly true of the Visayan Islands.

IGORROTE TRUCK FARMERS.

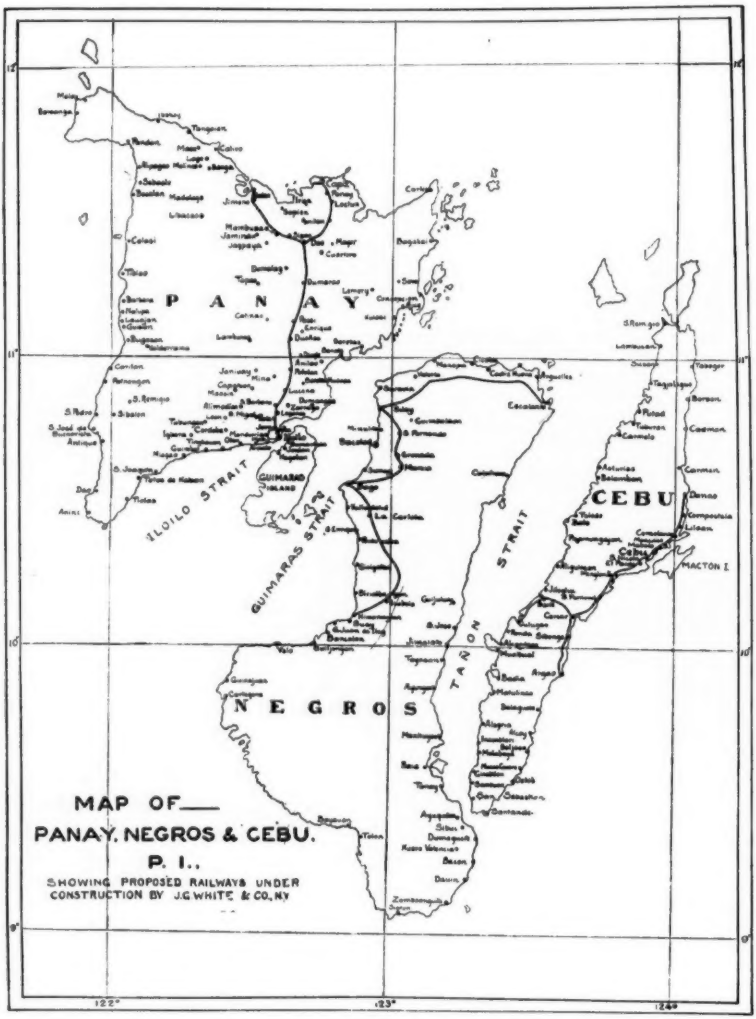
What has been said of the effect upon Philippine sugar growing, of the awakening of China, applies with fully as great force to the other great staple of the islands, hemp—to say nothing of the demands of the rest of the world for that article. One might continue and cite an hundred and one particulars in which China is destined, with diplomatic treatment, involuntarily to aid in the civilization and enrichment of the Philippines, without in a material degree affecting the trade between the United States proper and China.

The crying need is for transportation. There are thousands of square miles of fertile land lying virgin in regions quite free from serious menace by hostile tribes and in which the natives for the most part live peaceful, agricultural lives. I refer to a large portion of Luzon, and to nearly all of the three largest islands of the Visayan group—Panay, Negros, and Cebu.



By courtesy of Mr. Wm. Dinwiddie

CULTIVATING RICE FIELDS WITH WOODEN TOOTHED HARROW PULLED BY CARABAO.



MAP OF THE ISLANDS OF PANAY, NEGROS, AND CEBU

Showing the railways projected and under construction. Scale about 21 miles to the inch.

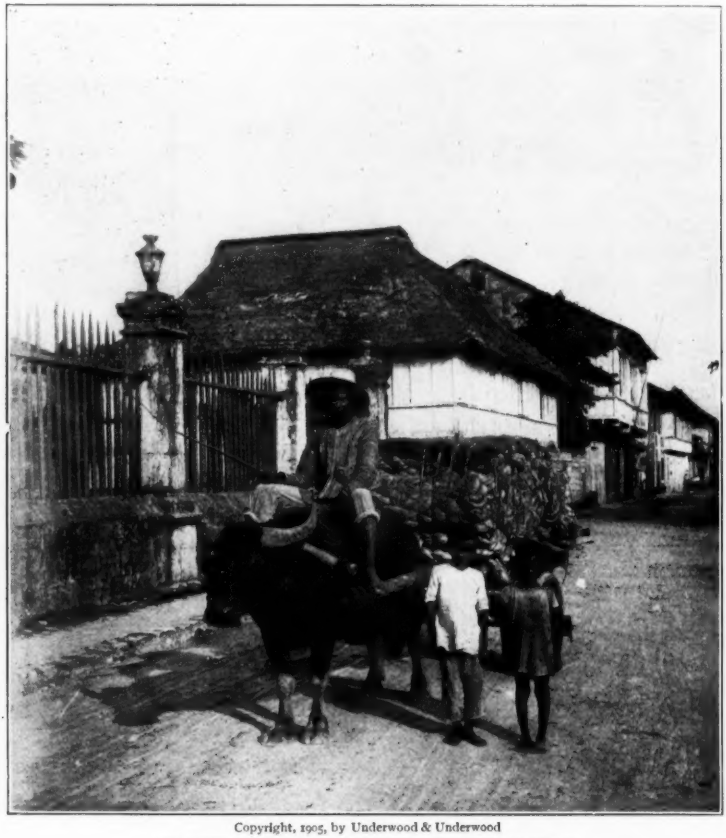
Because of the pressure of this great necessity for transportation facilities, the insular Government has had under consideration, for some time, definite plans for the inauguration of an extensive system of railroads, looking toward the material betterment of the Filipino; the contract has been finally placed with J. G. White & Company of New York, for the construction and operation for thirty years — operation to become optional thereafter — of 300 miles of road, almost equally divided between Panay, Negros, and Cebu. These are, at the same time, very thickly populated and among the richest in agricultural resources of the Philippine Islands, while Cebu contains certain mineral riches.

IGORROTE WOMEN RETURNING FROM THE FIELDS WITH WELL FILLED HEAD BASKETS.

It is not inopportune here to digress slightly for the consideration of the general status of modern transportation utilities in the Philippine Islands, indicating at the same time the part thus far played by the natives as workmen, operatives, and patrons.

The only steam railway of any magnitude in the archipelago is the Manila & Dagupan Railroad, built chiefly with British capital and by British engineers. The main line was completed in 1894, and, while primitive in the light of the best European and American practice, it is nevertheless a highly important and well-patronized road. The direction is generally north and south, and the terminals are Manila and Dagupan, 122 miles apart. A branch line, 86

miles long, is nearing completion, the terminus being Cabanatuan, an interior town northeast of Manila and east of Dagupan. This line is being built under concessions granted by the insular Government, and will be similar in all cardinal respects to the main line.



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INLAND FREIGHT CARRIAGE, ISLAND OF CEBU

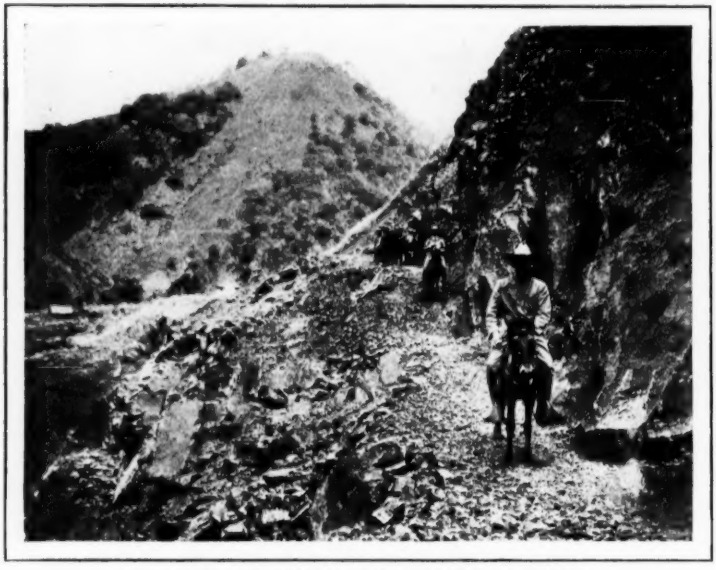
A load of Manila hemp coming to market.

The passenger traffic of this system is over 1,000,000 per year, of whom 95 per cent. travel third class. The freight traffic aggregates about 10,000,000 ton-miles. The gross revenue has averaged from $1,000,000 to $1,250,000 per year, of which nearly 66 per cent is derived from the passenger service. The gross profit is about $400,000

PHILIPPINE PASSENGER TRAFFIC. CHAIR CARRIERS ON THE TRAIL.

per year, on a property valuation, excluding franchise, of $10,000,000. And this has been during the reconstruction period of the government, when traffic was probably but a fraction of what may be expected now that more stable and healthful conditions are established. That the mere presence of the American element has not directly augmented traffic is shown by the maintained high percentage of third-class

CHAIR CARRIERS AND PACKERS RESTING ON A MOUNTAIN TRAIL

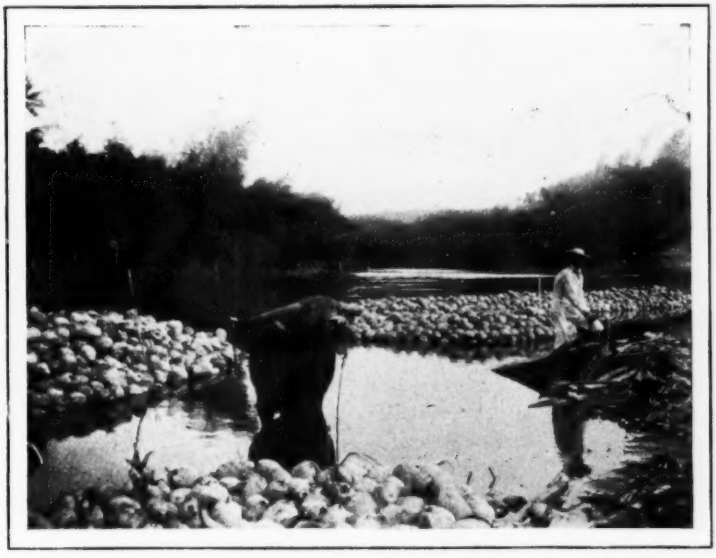


THE MOST MODERN MODE OF TRAVEL IN PANAY.

passengers through the period of transition and the almost negligible percentage of first-class, which would include Americans. Still, the business has been altogether more prosperous than during the Spanish sovereignty, despite the disturbed condition.

The gauge of the Manila & Dagupan road is 3 feet 6 inches, the rails weigh from 50 to 60 pounds to the yard, and the ballast is rock and sand. There are nearly three-hundred bridge structures, nearly all of masonry and steel, and the whole line and equipment are in an excellent state of repair. The rolling stock is diminutive and inadequate, but the operation of the line furnishes nevertheless a reliable criterion for the organization of new railroad enterprise. It shows, roughly, in how far assistance and patronage are to be expected of the natives. Operating expenses on the Manila and Dagupan line are only 45 per cent of the total charges. Natives make very cheap and fairly efficient section hands on maintenance of way, and, what is more noteworthy, good locomotive drivers and section foremen. The wages for each class of workmen are from a quarter to a third of what is paid in the United States, and the difference in efficiency does not balance the account.

The entire 200 miles of the Manila and Dagupan system has been



AN ASPECT OF NATIVE PHILIPPINE WATER TRANSPORTATION.

Tame carabao and cocoanut rafts, Pagsanjan River, Manila.

built with native labor but it traverses a district where labor is plentiful. Altogether the assistance given in construction work is satisfactory. In operation the only serious difficulty with the native employees results from a well developed striking propensity. The managers have learned from experience that the best antidote is patience, so work is simply suspended in as far as is necessary, until the strike dies a natural death. The striker generally tires of striking with a readiness quite inconsistent with his apparently always-present readiness to strike.

The volatile temperament of the native is a never-ending source of difficulty to managers of industrial and engineering undertakings in the Islands. Oftentimes this weakness is made stock of by unscrupulous native Government officials to further their own ends, and one can never tell quite how he stands with this gentry. One incident will serve to illustrate the point.

In 1904 I undertook the building of a Government road in northern Pangasinan, a Luzon province. For the purpose a part of what is known as the $3,000,000 Congressional Relief Fund was appropriated. A meeting was arranged between myself and the native provincial

TRANSPORTING ORANGES BY WATER, NEAR MANILA

governor on the one hand, and the town officials on the other, with the object of making clear the nature of this public benefaction. Hearty co-operation was assured us in the undertaking. Work was started under these favorable auspices, with an abundant supply of eager workmen. However, at the end of two weeks, on the day following pay day, there appeared but a paltry seventy men instead of nearly a thousand. This instant change of front of course, indicated the presence of some malign influence, and our suspicions were further aroused by a call from the mayor during which he feigned great surprise and regret at our predicament, and promised his assistance in gathering a new corps. We perceived no result from this promise, and our suspicion was practically confirmed by a subsequent visit of two of the town council. These worthies, after beating all around the bush, came to the point with the statement that our trouble was due

PHILIPPINE WATER TRANSPORT. 20,000 COCOANUTS ON RAFTS IN PAGSANJAN RIVER.

to ignorance in handling native labor, and forwith proposed to manage the matter for us on a contract basis at 30 cents per head per day, the authorized rate. Here was the suggestion of "graft" in all its modern refinement. The rascals even offered guarantee.

We instituted a secret investigation, and fortunately secured to our service an ostensibly honest city father, with whose aid a *dénouement* was effected. Here was presented a fat opportunity to

NATIVE LABORERS BUILDING A ROAD THROUGH ROUGH COUNTRY.

pilfer the devoted federal Government; so it was planned, after having bound us by the contract scheme, to "squeeze" 10 cents daily on the individual wages paid by us. The contented state of the labor was completely revolutionized, by reports surreptitiously circulated, of our inability to pay further wages on account of depletion of funds.

We frustrated the machinations of the town fathers when we informed them that our paymaster was bonded to deliver personally the wages of every laborer engaged for the Government work. Then began a long fight between ourselves, determined to build the road, and the local officials, determined to obstruct all progress. They operated by spreading alarmist reports, affirming that we intended to beat and even kill enployees, and to confiscate draught animals

OPENING THE WAY FOR URBAN RAPID TRANSIT.

loaned for the work. We succeeded, nevertheless in mustering an average of four-hundred men on the job, chiefly by kind treatment and prompt payment at frequent intervals. It was never possible to get sufficient evidence to convict the malefactors, as they operated through secret channels and enjoined silence by dire threats of mutilation of the speaking organism of any tale bearer.

A part of the scheme for railroad expansion proposed by the Government consists in an extension of the Manila & Dagupan system amounting to about 400 miles. However, definite arrangements for the construction of these extensions have not yet been made and there is but one bidder for the contract, Speyer & Company, of New York.

Of quite as great importance in the public-service utilities of the Philippines as the Manila & Dagupan Railroad, is the Manila Electric Street Railway, built and now operated by J. G. White & Company, New York. The holding company is the Manila Electric Railway & Lighting Corporation. There are in this system 40 miles of modern, high-grade street railway, which, with the power house and lighting

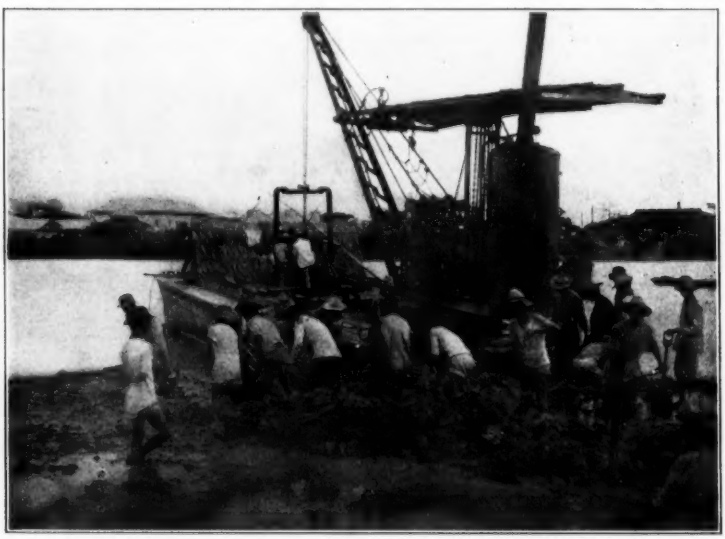
equipment, constitutes the most complete electric service plant in the Far East.

The bonded investment, covering also the value of the plant of the old lighting company, "La Electricista," which has been superseded by the new organization, is $6,000,000. This property, opened to the public on April 15, 1905, was established on a paying basis the first of this year. All the car operatives and many station men are native Filipinos.

It was generally feared that the well-known tendency toward instability in the native character, would manifest itself in this work—probably more exacting than any which natives in numbers had hitherto been called upon to perform. But the results of a year's trial are most satisfactory. The operation of a modern electric street-car in the crowded streets of an oriental city, where traffic and pedestrians are absolutely at variance with and antagonistic to so foreign an element, calls for the full measure of steadiness, tact, and resourcefulness to progress expeditiously without accident. One must have

NATIVE TRACK LAYERS, TRAINED TO AMERICAN TOOLS.

experienced the conditions to appreciate them. The narrow escape of a pedestrian from the wheels of a vehicle is generally acclaimed with delight by all observers, and with derisive equanimity by the principal, who has probably split the last second in estimating his chances. It seems to be one manifestation of the lust for the game of chance which is the besetting sin of most Orientals. Under these circumstances, the almost complete freedom from accident in the operation of the Manila street railway during its inaugural year is a singular commentary on the possibilities of the Filipino character. The conductors, as well as the motormen, have proven their adaptability and, thus far, have discharged their duties with honesty and decorum. I have seen a body of these native motormen and conductors assembled, ready to go on duty, and their businesslike appearance and demeanor are striking. We are accustomed to see in the Filipino face a certain sort of smartness and alertness, but painstaking tutelage has developed the more substantial virtues in these men, if facial lineaments are any indication.



NATIVE FILIPINOS AS LABORERS ON ENGINEERING WORK.

In the installation of this railway and lighting system, it was, of course, necessary to depend upon natives to make up the rank and file of workmen and artisans. In most cases they had to be educated to their tasks,and men who came to the company the rawest of raw

laborers, without even knowledge of the use of so rudimentary a tool as the shovel, were turned out finished craftsmen in the course of the work, capable of acquitting themselves creditably as structural-steel workers, and in other skilled lines.

PRESENT METHOD OF DISCHARGING CARGOES FROM LIGHTERS, CEBU.

The completion of harbor improvements and railways on this island will make this a busy port.

So there is already established, by virtue of these various enterprises, the basis of a skilled working class in the Philippine Islands, which will materially modify the difficulties of the construction of the new railroads. All that has been cited in this reference applies with special force to Luzon, but the effect will undoubtedly manifest itself in the engineering undertakings throughout the archipelago. There is, moreover, a factor of the labor situation that bears directly on the projected railroad work.

A part of the general scheme for developing the resources of the Visayan Islands consist in harbor improvements, along which lines the company that will build the railroads has already carried out important works at Iloilo and Cebu. At these points there have been established modern and fully equipped machine shops, which will no doubt be of inestimable service. In connection with them, there is gathered together a trained working corps of some magnitude on the precise field now to be further exploited.

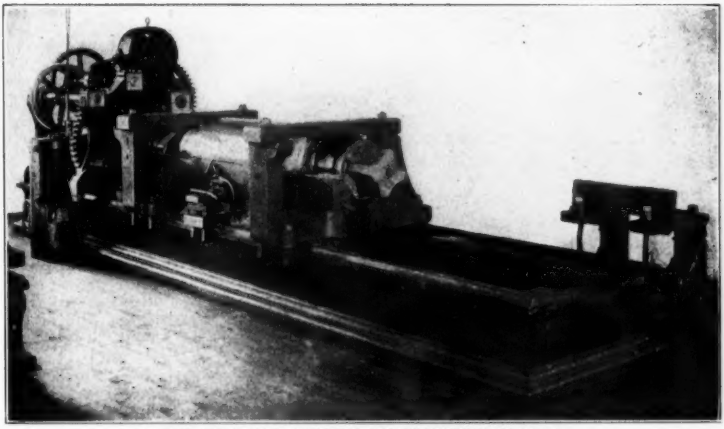
Nearly a million dollars have been expended on these harbor works at Iloilo and Cebu. At Iloilo there have been built stone dikes over a mile long on either side of the Jaro River, terminating in jetties. Between the walls and jetties the river is being dredged to make a uniform channel with a minimum depth of 16 feet and a width of 400 feet. The dredged material is used for filling behind the dikes.

DISCHARGING THE CARGO OF A STEAMER BY CASCOS AND CARABAO CARTS, HARBOR OF CEBU.

The main feature of the Cebu improvements is a concrete sea-wall, a mile long, founded on piles 10 feet below mean low-water level. It is located on the harbor foreshore to form a bund, the material dredged from the harbor being used for filling behind the wall. The dredged depth up to the bund will be 16 feet at mean low-water. In addition, wharves for sea-going ships are being built.

There has been little difficulty with labor on these works in the Visayan Islands. At 30 cents a day for unskilled workmen, the supply has been easily double the demand. The efficiency, despite good intentions, is low. The native, however, will accomplish as much as the white man in that environment, which is about one-third what a white man can do in the United States. The same applies roughly to average skilled labor. In all the industrial centers of the Islands, the average quality of "skilled workmen" is lowered by an element which masquerades under the cognomen, but which has had but a brief and superficial training. This state of affairs is a natural result of rapidly growing demand, and will doubtless be rectified with the further progress of engineering enterprise. As has been already noted, the artisans properly schooled under competent foreigners bear comparison with their white brethren in the field.

The undertakings at Iloilo and Cebu have been materially aided by native officials who, as contrasted with the attitude testified by the incident previously outlined, have pursued a sane and upright policy. Especially at Iloilo the president and governor are most honorable, intelligent, and sensible officials, who know their people and do only what is best for their interests. Their aid is highly valued.



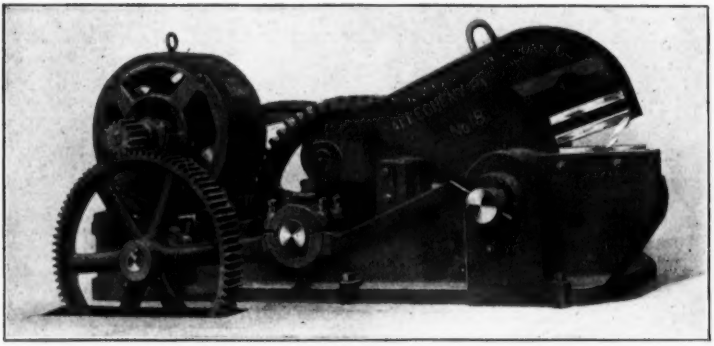
A ROLL LATHE DRIVEN BY ELECTRIC MOTOR.

SPEED CHARACTERISTICS AND THE CONTROL OF ELECTRIC MOTORS.

By Charles F. Scott.

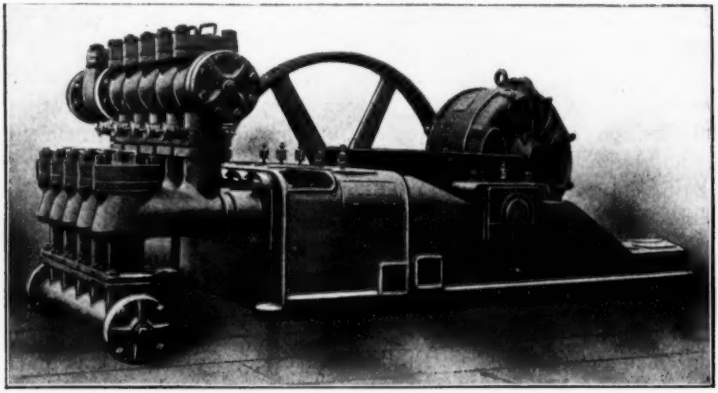
IN the preceding article the general characteristics of speed control of electric motors have been discussed, and particular consideration has been given to the characteristics of direct-current motors. Consideration will now be given to motors which are operated on alternating-current circuits.

The number of kinds of supply circuits for the operation of alternating-current motors is far greater than that for direct-current motors. Direct-current motors are, in general, supplied with current at approximately 110, 220, or 500 volts. Circuits for supplying alternating-current motors likewise differ in voltage and, in addition, they differ in frequency and in the number of phases supplied to the motor. Alternating-current motors are wound ordinarily for approximately 100, 200, 400, or 550 volts, and motors of large size are wound for pressures of 1,000 or 2,000 volts or higher. The greater range of voltages for which alternating-current motors are wound is made possible by the characteristics possessed by alternating-current apparatus. The

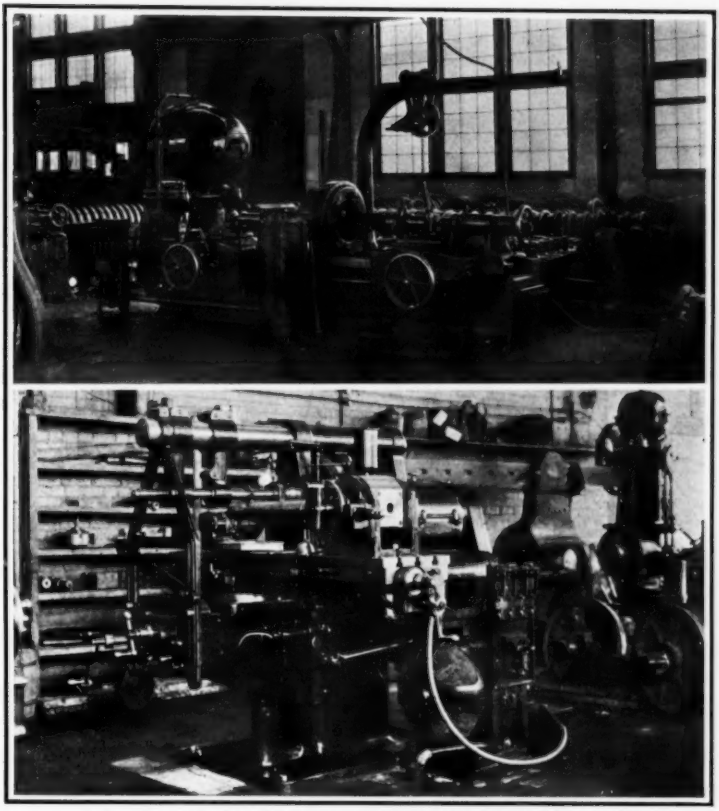


ALLIGATOR SHEAR DRIVEN BY WESTINGHOUSE MOTOR.

motor windings can easily be adapted for different voltages; in fact, in many cases motor windings may be divided into halves, which may be connected in parallel or in series, thereby adapting the motor for operation for either of two voltages, one of which is twice the other. A direct-current motor, on the other hand, has a commutator which does not permit changes in the armature winding and which adapts the motor for one particular normal voltage. The difficulty in commutation at high pressures, moreover, does not make practicable the operation of a direct-current motor at pressures much above 500 or 600 volts. The alternating-current motor has no such limitation and can be wound for much higher voltages, the principal requirement being a suitable increase in the insulation of the winding. While the design



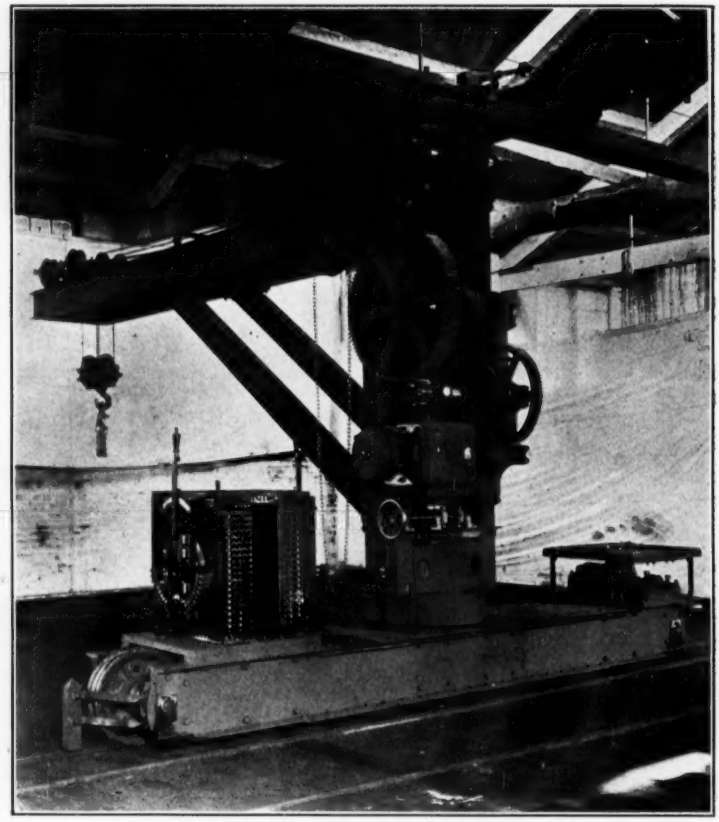
BYRON JACKSON MINING PUMP DRIVEN BY WESTINGHOUSE MOTOR.



EXAMPLES OF MODERN ELECTRIC-MOTOR TOOL EQUIPMENT.
The upper figure shows an axle lathe with Crocker-Wheeler motor multiple-voltage control in the P. & L. E. R. R. shops; the lower is a milling machine similarly driven.

of the motor itself can be readily adapted for any voltage over a wide range, on the other hand the supply circuit has an elasticity which is not possessed by direct-current apparatus, through the agency of the transformer. Generally speaking, a transformer may be wound with equal facility for giving any definite voltage, thus allowing the selection of the pressure best suited to a particular installation. Motors not exceeding 50 or 75 horse power are usually wound for voltages not exceeding 550; and motors of several hundred horse-power capacity are usually wound for higher voltages.

In addition to differences in voltage, circuits differ in frequency. This may be expressed either in alternations-per-minute, which gives

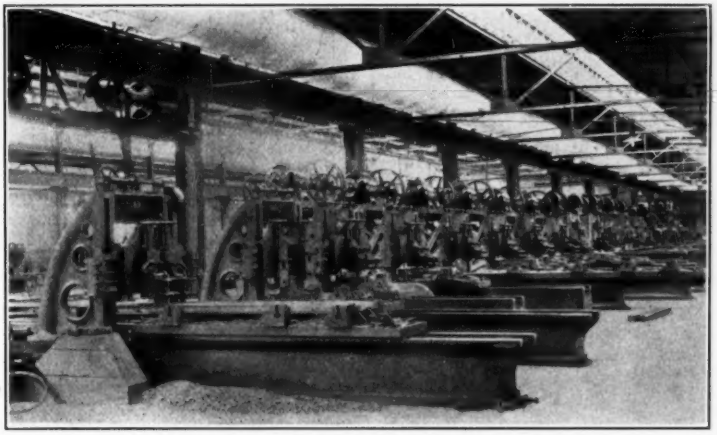


AN ELECTRICALLY OPERATED TRAVELING JIB CRANE.
Northern Electric Mfg. Co.'s box-type motor. Crane by Case Mfg. Co., Columbus, Ohio.

the number of reversals in the direction of the current per minute, and is equal to the number of field poles of the alternator multiplied by its speed in revolutions-per-minute; or, the frequency may be given in cycles-per-second, one cycle comprising two alternations. The most common frequencies are 3,000 alternations, or 25 cycles; and 7,200 alternations, or 60 cycles. These frequencies include a very large proportion of the alternating-current systems in use in the United States, and very few new plants are installed in which any other frequency is adopted. In other countries, however, frequencies intermediate between these standards are employed.

SLOTTER AND SHEARS, PITTSBURG & LAKE ERIE R. R. SHOPS.
Made by Hilles & Jones Co., and equipped with Crocker-Wheeler electric motors.

Another characteristic of alternating-current circuits is found in the number of phases which they supply. Single-phase circuits supply a simple alternating current. Polyphase circuits employ more than two wires and supply two or more currents, differing in their phase or time relation. The two classes are: two-phase circuits, in which there are two alternating currents differing in phase by 90 degrees; and three-phase circuits, which have three currents differing by 120

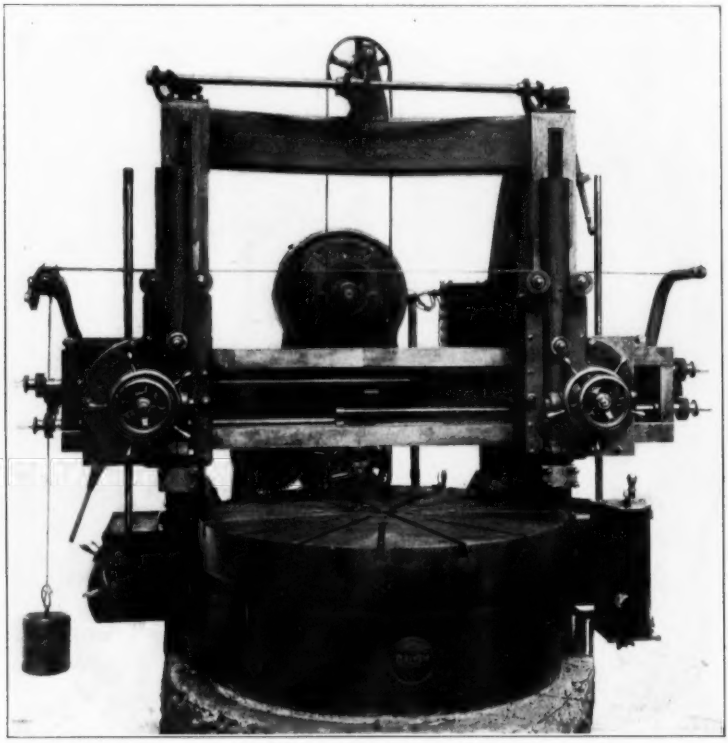


A ROW OF ELECTRICALLY DRIVEN PLANERS IN THE WEIR FROG COMPANY'S SHOPS.
Built by American Tool Co., and equipped by Allis-Chalmers Co.

degrees. The general relations between these three varieties of action may be illustrated by three types of reciprocating engines, namely, single-crank; two-crank, with the cranks set at 90 degrees; and three-crank, with the cranks set at 120 degrees.

In a given plant the frequency is fixed by the number of poles and the speed of the generator, which is constructed to give a definite number of phases. The number of phases and the voltage admit of change by means of transformers. Usually, however, all the motors in a given installation are made for a definite number of phases and a definite voltage. The choice of frequency and other characteristics is made when the plant is first designed.

The speed torque characteristics of alternating-current motors are essentially the same whether the motor be wound for high or for low voltage, for two or for three phases, or for high or for low frequency.

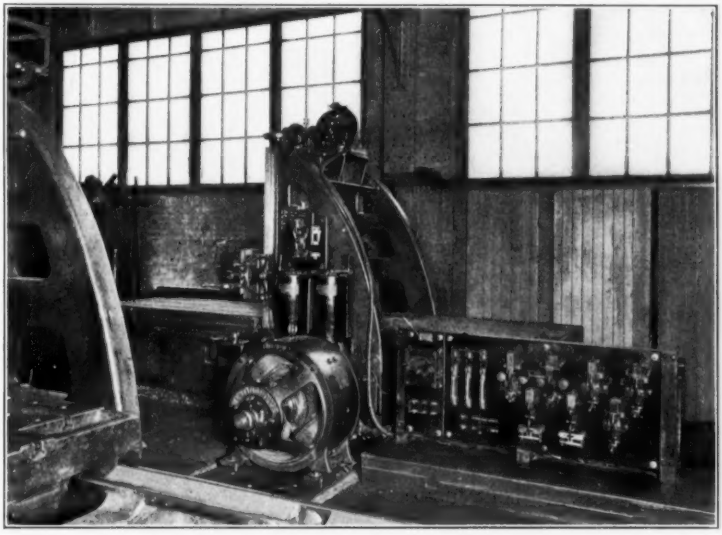


BAUSH BORING MILL DRIVEN BY WESTINGHOUSE MOTOR.

Types of Alternating-Current Motors.

Alternating-current motors are of several types, the principal characteristics of which will be briefly discussed.

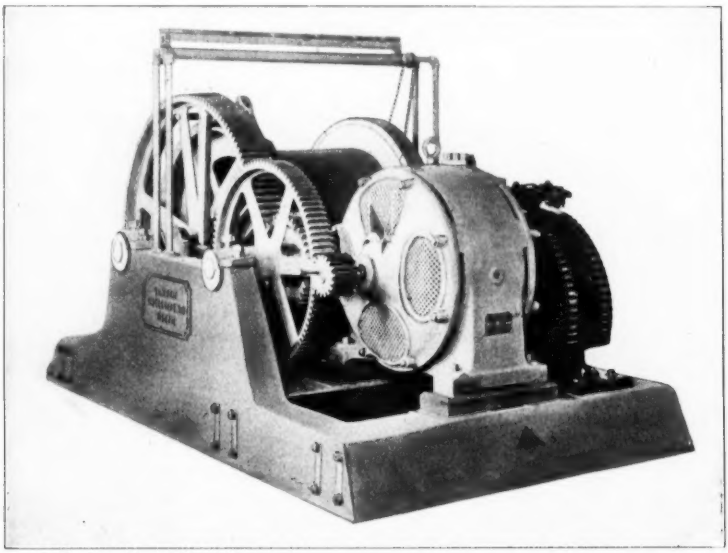
The synchronous motor operates at an absolutely definite speed, which is in a definite ratio to the speed of the generator which drives it, and is dependent upon the relation of the number of field poles in one machine to that in the other. This motor is used principally in large sizes, and is not generally employed in small units in the general distribution of power. It usually requires an auxiliary exciting current and a greater degree of care in attendance than is necessary with



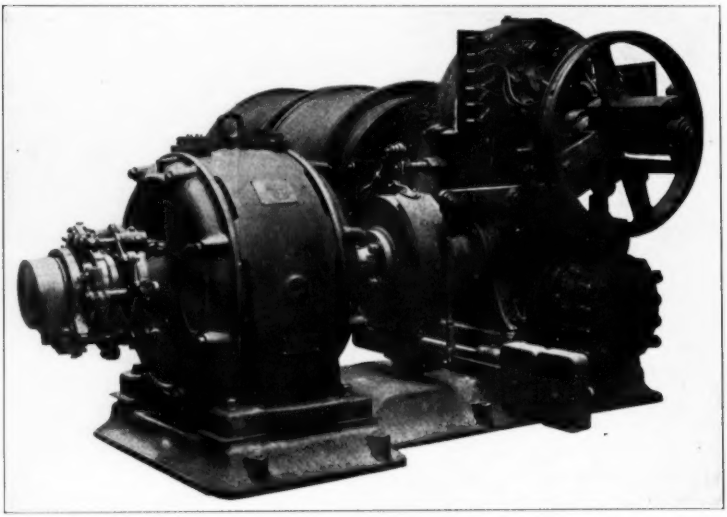
POND PLANER, 36 BY 36 INCHES BY 12 FEET, WITH ELECTRIC CONTROLLER & SUPPLY COMPANY'S DIRECT-CONNECTED VARIABLE-SPEED MOTOR DRIVE, SHOWING DETAILS OF CONTROLLERS.

other types of motors. It admits of no speed variation unless the speed of the generator is changed. It is not self-starting with load.

The polyphase induction motor is so well known that it needs no extended description. There are several common types of induction motors. The first is provided with a rotating secondary of the squirrel-cage form, the winding of which consists of a number of copper rods laid in slots in the core and connected at each end to metal rings. This motor tends to run at a definite speed, depending upon the



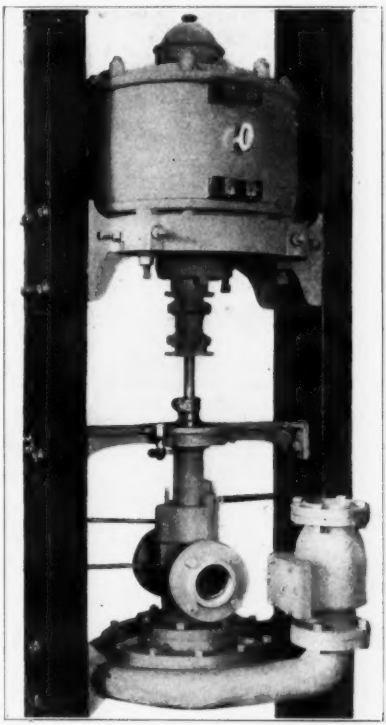
DENVER ENGINEERING WORKS' HOIST DRIVEN BY WESTINGHOUSE MOTOR.



MORSE WILLIAMS & COMPANY'S ELEVATOR DRIVEN BY WESTINGHOUSE MOTOR

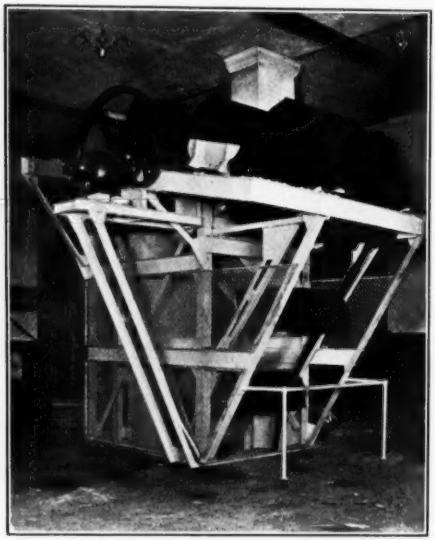
number of its poles and the frequency of the circuit from which it receives its current. The actual speed approaches very close to the theoretical speed at no load and falls off from it as the motor is loaded. If the end rings to which the bars on the secondary are connected have a low resistance, then the speed decreases but slightly with load, and the motor is practically a constant-speed motor. Its running characteristics are quite similar to those of the direct-current shunt motor, except that the normal speed of the latter may be varied by changes in its field strength, whereas the induction motor has but one definite speed.

If the induction motor has end rings of relatively high resistance, then the speed falls off to a marked degree as the motor is loaded. The characteristics of this motor correspond approximately to those of a direct-current shunt motor having a resistance connected into its armature circuit. A direct-current motor under these conditions has a decreasing electromotive force upon its armature terminals, and, consequently, a decreasing speed with increase of load. An induction motor with high-resistance end rings may be proportioned so as to give an increase in torque with lowered speed until a maximum torque is reached at rest. The starting torque, and likewise the torque at any definite speed, is dependent upon the electromotive force applied to the motor. At a reduced electromotive force there is a reduced torque. If the motor be supplied with a controller, by which different electromotive forces may be applied to the motor, the motor is under com-



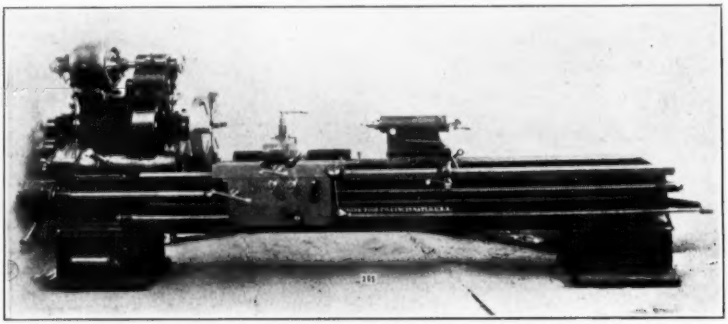
BYRON-JACKSON CENTRIFUGAL SINKING PUMP OPERATED BY WESTINGHOUSE MOTOR.

plete control for variable-speed work, such as hoisting and the like, as it may develop any torque at any speed over a wide range. The speed conditions, however, are unstable, and a change in load will result in a change in speed.



NORTHERN ELECTRIC MOTOR DRIVING JEFFREY ELEVATOR, HANDLING MAIL IN THE CHICAGO POST-OFFICE.

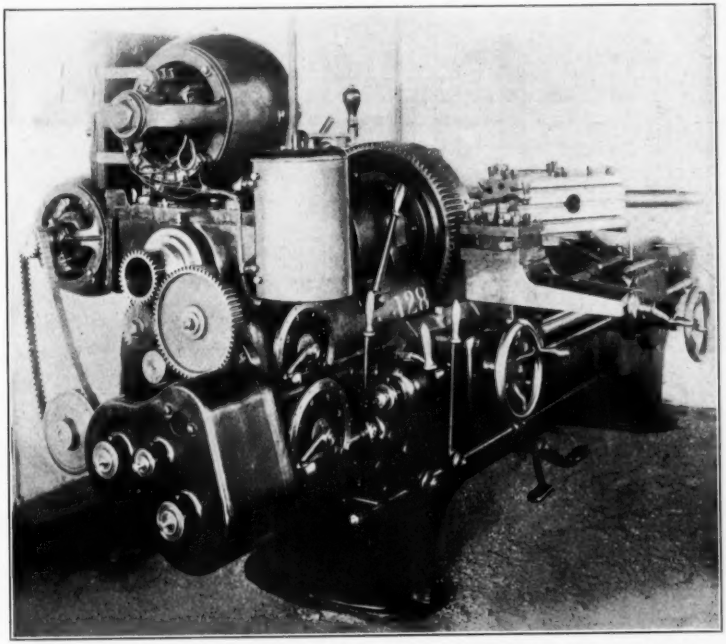
An induction motor may be constructed with a rotating secondary having a continuous winding which is connected to collector rings from which the current is conducted to a rheostat. By adjustment of this rheostat, the characteristics of the motor may be varied from those of a motor having a high secondary resistance to those of a motor having a low resistance; that is, from a motor which gives large changes in speed with change in load to one which has very small speed variations with change in load. This resistance in the secondary circuits is equivalent to a variable resistance in the armature circuit of a shunt motor. The analogy between the



A METHOD OF MOUNTING THE CONTROLLER ON AN ELECTRICALLY DRIVEN MACHINE TOOL.

The controller (Cutler-Hammer System) on the left is operated from the post by means of shaft, chain, and sprockets.

two includes the relation between efficiency and speed. Under any condition of speed, the total power which is received by the rotating secondary appears as internal losses and as mechanical energy developed. The mechanical energy is proportional to the speed. For example, if the speed be 90 per cent of that at no load, then the mechanical energy developed is 90 per cent. The control of an induction motor by resistance in the secondary is useful in starting the motor, and for various conditions requiring speed control, particularly where the motor is under the control of an attendant, and in which the proportion of operation at slow speed is small.



CUTLER-HAMMER DRUM CONTROLLER MOUNTED ON THE TOOL WITHIN REACH OF THE OPERATOR.

Characteristic curves of an induction motor are given in Figure 3. The horizontal scale is plotted in pounds-torque at one foot radius and the vertical scale in speed and horse power. The various speed curves correspond to different amounts of resistance in the secondary circuit, the various resistances being introduced or cut out by placing the controller handle on successive notches. On the first notch the resistance

is a maximum and the torque developed is therefore relatively small. The torque is maximum at starting and decreases uniformly as the speed increases. If the controller handle be moved to the second notch the torque corresponding to any speed is increased. When the secondary is short-circuited the torque corresponding to a given speed is a maximum. This statement, however, does not apply at low speeds, as the torque reaches the maximum and then falls off. As the torque decreases the speed approaches a certain definite maximum. It will be noted that the upper curve showing the condition with the secondary short-circuited is approximately a constant-speed curve, as the fall in speed is slight until a considerable torque is attained.

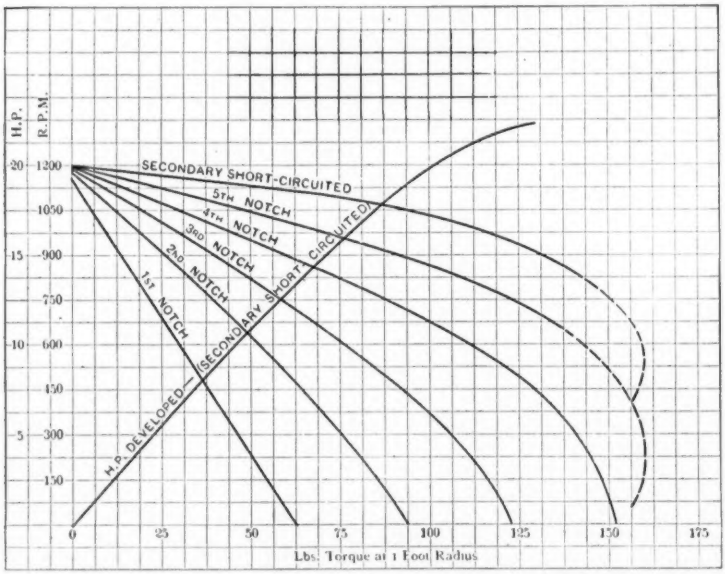
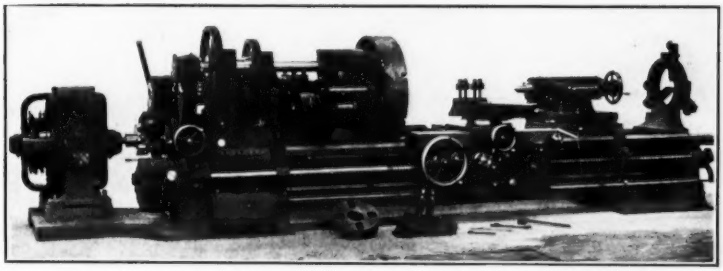


FIG. 3. CHARACTERISTIC CURVES OF AN INDUCTION MOTOR.

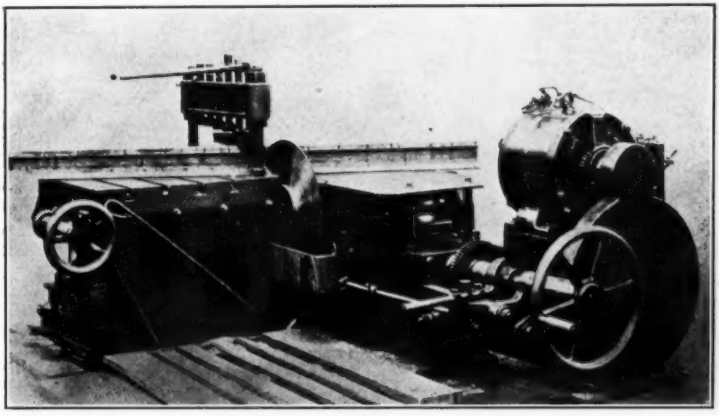
The group of speed-torque curves for the induction motor shows that over a considerable range various relations between speed and torque can be secured. If the motor is carrying a load with resistance in the secondary circuit, a change in load will cause a change in speed. This method of control by the introduction of resistance in the secondary is in many respects quite similar to the control of a shunt motor by resistance in its armature circuit. The variation of speed with load, the relative performance with different amounts of resist-



GENERAL ELECTRIC MOTOR DRIVING A 36-INCH SHIPLEY LATHE.
Direct-current, 220-volt, 20 h. p. motor, 550-1500 revolutions.

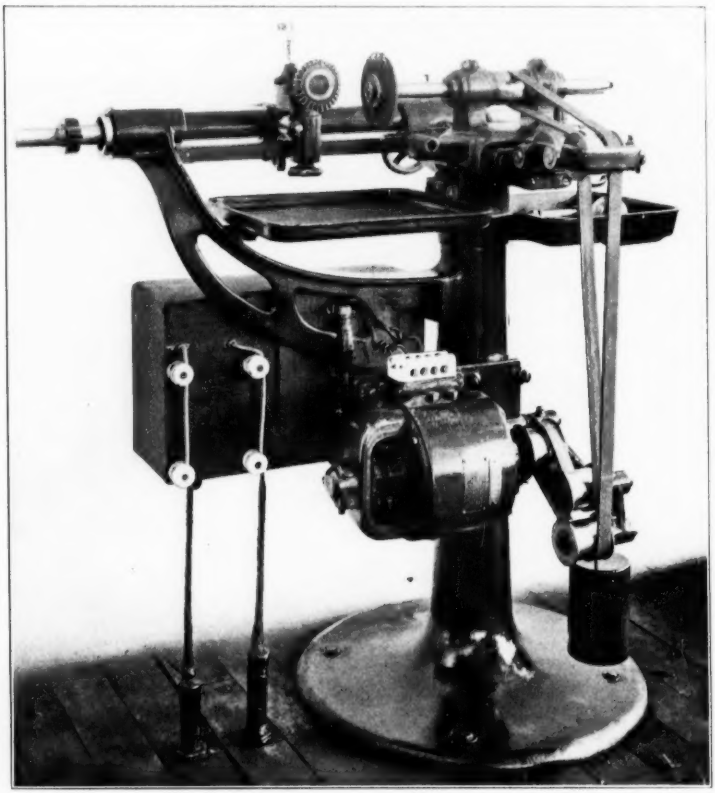
ance in circuit, and the relation between losses in the resistance and the useful power developed correspond closely in the two cases. This comparison is useful in a general consideration of the performance of the induction motor as direct-current operation is more easily understood than is the alternating-current motor, as one is apt to be confused by the consideration of phases, power factors and the like, which have little to do with the speed-torque relations.

There are certain special forms and methods of operating induction motors which give speed characteristics other than those of the simple form of motor which has been considered in the foregoing paragraphs. A multi-speed induction motor may be obtained by placing on the motor two windings for different numbers of poles. A



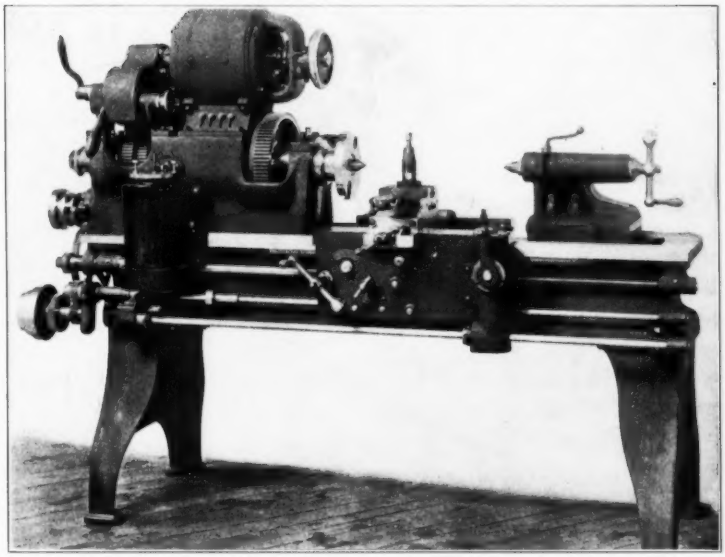
NEWTON CUTTING-OFF SAW DRIVEN BY ALLIS-CHALMERS MOTOR.
Shops of the Weir Frog Co.

winding having twice as many poles as another winding will give half the speed. The second winding may be entirely independent of the first, or the same coils may be employed and the connections between them may be changed by means of a switch or controller so as to produce either four poles or eight poles, thereby affording either of two speeds. A change of this kind has its mechanical equivalent in a change in gear ratio.



GENERAL ELECTRIC MOTOR DRIVING BROWN & SHARPE TOOL GRINDER.

Another method of obtaining a second speed by means of induction motors requires two motors with provision for supplying current for the second motor from the rotating secondary of the first motor. If the two motors have the same number of poles then the speed



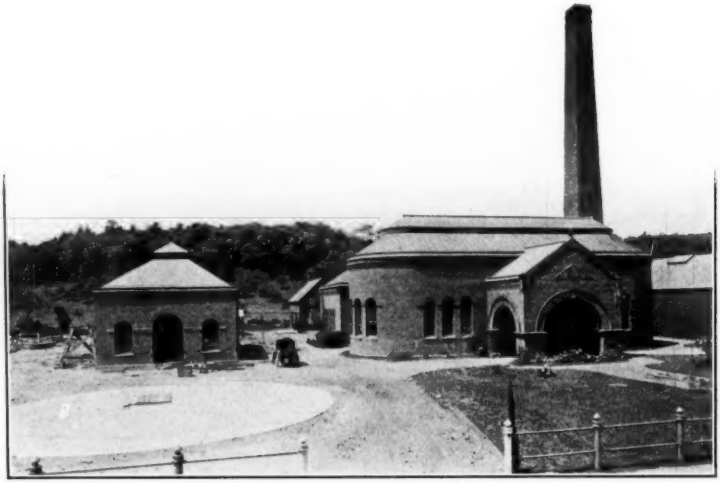
REED 16-INCH LATHE RUN BY GENERAL ELECTRIC MOTOR.
One horse power; speed variable from 500 to 1,500 revolutions.

when connected in tandem is one-half. The method is employed in railway work, in which the motors are connected in tandem for starting and then may be connected independently to the supply circuit for running at full speed. This method, however, has very little field of application, particularly for small amounts of power.

Alternating-current motors with commutators have, in a general way, characteristics similar to those of direct-current motors. The single-phase series motor is being introduced for railway work. Motors of the same type are suitable for the operation of hoists, cranes, and the like, and have approximately the same characteristics as direct-current series motors. It is likely that commutator motors will, in the future, have an increased and important application aside from electric traction.

A popular review of the speed characteristics of motors must be quite general if it is to avoid a maze of details and special constructions. During the past few years there has been a great amount of designing to meet specific conditions. Motors are made to have various ranges of speed and with the particular torque curves which best fit them for operating elevators or pumps or bending rolls or

other specific service. The same motor in electrical construction is made in different mechanical forms. The degree of this specific adaptation to particular conditions is most strikingly shown by comparing the motors which are now available with the standard motors of ten years ago. One of the large electric companies at that time did practically all of its stationary direct-current motor business with a "standard-speed" and a "slow-speed" motor. Instead of these two kinds, it now offers motors for a given output which are made in ten or a dozen mechanical forms, such as open, semi-closed, enclosed, vertical shaft, one, two or three bearings, with back gear, with idler pulley, inverted and side mountings for ceiling or wall suspension and the like. These different forms are wound for a great variety of speeds and speed ranges. For the field which was covered a few years ago by a dozen motors, there are now hundreds, each adapted to particular conditions, and even yet cases are continually arising which call for new designs.



AN EXAMPLE OF ELECTRIC-DRIVEN AS COMPARED WITH STEAM-DRIVEN MACHINERY.

Rotterdam, N. Y., Water-Works. The electric pumping station on the left has a capacity of 24,000,000 gallons daily; the steam pumping station on the right, of 12,000,000 gallons daily. Electric equipment supplied by the General Electric Company

A STOCK-KEEPING SYSTEM FOR GENERAL STORES.

By F. W. Jessop.

The system described by Mr. Jessop, like others which have been presented in preceding articles in this series, is in actual successful use under the immediate direction of the author. The demonstration is therefore as practical as the methods themselves. In the case of the Electric Controller & Supply Co., of which Mr. Jessop is Superintendent of Production, the stores department is particularly interesting because of the notable efficiency with which it cares for a multiplicity of small parts.—THE EDITORS.

ALMOST the entire product of the company whose store-room methods are here described goes to steel mills, blast furnace plants, iron and steel foundries, and similar industries. It consists mainly of controlling apparatus and friction brakes for reversing motors, and of lifting magnets.

A series reversing motor is absolutely at the mercy of the operator, except where controlling apparatus designed to limit overloads is used; hence it is evident that no other apparatus in a mill is so liable to injury as the motors and controllers. This explains the existence in every large city of companies prepared to furnish commutators and armature and field coils for all standard makes of motors on short notice; it also has led The Electric Controller & Supply Co. to be prepared at all times to ship renewals for wearing parts of controlling apparatus promptly, and to ship controllers complete in from fifteen to thirty days from receipt of the order.

To accomplish this, it is essential that the order be interpreted correctly and transmitted to the shop with all necessary information, that job cards and stock be issued to the shop promptly, and that the shop work be so conducted that, at this stage, practically nothing is required but to assemble, test, and ship.

To this end, we have adopted a system of order-quantities and of low limits in raw stock, finished parts, and assembled parts, based on the monthly requirements but in many cases affected by economies in buying and manufacturing. This system is described further on.

Customers' Orders. When an order calls for special apparatus, the purchasing agent, who also has charge of stock and of the shop office, orders all necessary raw material not carried regularly—pat-

terns, castings, etc.—after which the order takes the same course as an order for standard apparatus, except that he usually indicates how he wishes the work issued to the shop so as to give suitable subdivision of the costs for the benefit of the sales department. Forms A, B, C, and D are used to issue a job to the shop and, as shown, they call for 50-V-159A controller arms.

Shop No. 6314 Job No. 5510
O.K. John Brown V159A

THIS CARD MUST STAY WITH THE MATERIAL, AND IS TO BE RETURNED TO STOCK ROOM WITH THE MATERIAL WHEN JOB IS FINISHED.

Assemble 50 arms V159A

DRAWINGS 447

DATE STARTED 1/1/06 DATE FINISHED 2/3/06

DATE RECEIVED		DATE RECEIVED		DATE RECEIVED
DRILLING AND TAPPING		SHAPER		GRINDING
LATHE		PUNCH PRESS	V	ASSEMBLING
SCREW MACHINE		INSULATING		STOCK ROOM
BORING MILL		WINDING		
MILLING MACHINE		POLISHING		

The Engineering Magazine

FORM A. WORKMAN'S AUTHORIZATION FOR BEGINNING A JOB.
original is 6 by 4 inches in size.

Form A is the workman's authority to work on the job; it follows the material to its completion and is returned to the stock room with the finished stock. This form also indicates the rotation of work in the shop. Form B, not shown, is a partial carbon copy of form A and is filed numerically for reference purposes only. It contains only the shop and job numbers, the list number, and the memorandum "Assemble 50 V-159A."

Form C on its face is a copy of Form A, and on the reverse side, as shown, contains a list of the raw and finished stock required. It is kept in the office until the job is completed. Form D, not shown, is a carbon copy of the reverse side of Form C, but with the ruling to the right replaced by a single wide column "Actual No. Used."

When the job is assigned by the superintendent, Forms A and D are sent to the stock keeper and are his authority to issue the stock, D showing the stock required. Practically all stock is issued in this

SHEET NO. 1 SHOP NO. 6314 JOB NO. 5510

MATERIALS CARD

DATE ISSUED 1/16

DATE DUE AT STOCK ROOM 2/10/06 DATE RETURNED 2/11/06

Assemble 50 V1 Arms

Drg. 447

DRAW'G NO.	LIST NO.	MATERIAL	NO. REQUIRED	ACTUAL NO. USED	@	MATERIAL	HOURS	LABOR COST	FACTORY EXPENSE	TOTAL FACTORY COST
448	V145	Arms	50							
"	V146	Finger Holders	100							
"	V147	Fingers	200							
449	V149	Bolts	50							
"	V150	Finger Bolts	50							
"	V151	Springs	200							
450	V146	Vulca Bushings	200							
"	V161	Nuts	100							
"	V152	Mica Form	50							
"	V153	" "	50							
		1/4-20 Hex Nuts	200							
		1 1/2-14-20 R.H.I. Screws	200							

The Engineering Magazine

FORM C. OFFICE RECORD OF JOB COVERED BY FORM A.

The upper figure is the face, the lower, the back.
Original is 9 by 6 inches.

Serial No. 156 Shop No. 6846 Job No. 4411 Volts 220 Service Hoist H.P. 6½ Capacity Standard Folio No. 3 Special Drawing No. 449 Assembled by Smith Inspected and tested by Atwood Packed by McKinstry Date Shipped 2/15/06	Serial No. Shop No. Job No. Volts Service H.P. Capacity Standard Folio No. Special Drawing No. Assembled by Inspected and tested by Packed by Date Shipped	Serial No. Shop No. Job No. Volts Service H.P. Capacity Standard Folio No. Special Drawing No. Assembled by Inspected and tested by

In ordering Spare Parts for this machine refer to Serial No. 156 Shop No. 6846 In making claim for damages due either to imperfect packing or defective workmanship, please return THIS TAG with your claim. THE ELECTRIC CONTROLLER & SUPPLY CO.	**SHIPPER RETURN TO STOCK ROOM**	**TESTER RETURN TO STOCK ROOM**

The Engineering Magazine

FORM F. FACE AND BACK. ATTACHED TO STOCK WHICH GOES TO TESTING ROOM.

The original is 10½ by 2¾ inches. The sections detached along the perforated lines and returned to the office by the tester and shipper are automatic notifications of the completion, test, and shipment of the apparatus. The stub end identifies the apparatus to the customer.

E.C. & S. CO.'S Standard "W" Resistance

30 H.P., 220 Volts, BRIDGE **60 H.P., 220 Volts, HOIST OR TROLLEY**

Job No. 44112

Drawing No.	List No.	DESCRIPTION	Pat. No.	No. Req'd	Wanted	Actual No. Used
1017	V-233	Resistance Grid	1100	12	24	
1018	V-234	Resistance Grid	1101	12	24	
1012	V-235	Resistance Grid	1142	60	120	
1019	V-240	Insulating Button		94	188	
1019	V-238	Terminal	1098	16	32	
1002	V-243	Spacer	1094	38	76	
1002	V-245	Spacer	1096	12	24	
1020	V-230	End Frame	1097	4	8	
1019	V-236	Bolt, ⅜"x 10"		8	16	
		Jam Nut, ⅜"		16	32	
1019	V-241	Washer copper		136	272	
1019	V-242	Washer, mica		16	32	
1019	V-247	Tube, mica		8	16	
		Screw, 142014 R.I.		32	64	

The Engineering Magazine

FORM G. USED FOR RESISTANCE PARTS OF CONTROLLERS.

Original is 4½ by 5½ inches. The printed list averts the danger of omission, where so many small items are involved.

way and much time is saved over the old way of issuing a card to the man and having him call for the stock as needed.

In addition to the above, all resistance banks and all apparatus which when complete will pass directly to the testing department and shipper, carry the tag Form F, the two end parts being returned to the shop office by the tester and shipper, thus automatically notifying the shop office of the completion, test, and shipment of the ap-

PREVIOUS PRICE 1.00 DISC. 50 NET PRICE, 50 gr. MATERIAL Mach. Sers 14-20
PRESENT PRICE 1.00 DISC. 50-10 NET PRICE, 45 " KIND R H Brass HIGH LIMIT 50 gr.
FREIGHT OR EXPRESS 01 gr. COST PRICE, 46 SIZE 5/8 LOW LIMIT 25 gr.

RECEIVED					GIVEN OUT				BALANCE	
DATE 1906	FROM	V	QUANTITY	WEIGHT	DATE	QUANTITY	WEIGHT	JOB NO.	QUANTITY	WEIGHT
1/10	J.D.S. Supply Co	V	50 gr		1/11	25 gr		6811	25 gr	
1/10		V	25 "		1/15	25 gr		6913	—	
2/1	Jones Co		50 gr		1/15	25 gr		7115	50 gr	

The Engineering Magazine

FORM I. RECORD OF RAW STOCK RECEIVED.

Original is 6 by 4 inches. Form shows standard order quantity and low limit, and carries all information necessary for inventory, pricing, and buying purposes.

paratus. The stub-end remains attached to the apparatus and enables the customer to identify it, as he has previously received a "Customer's" copy of our general office order.

In the case of standard apparatus, quantity job-cards to manufacture complete (except parts which vary) are issued as needed, so that when an order comes in for a particular size it is necessary only to issue the stock for the variable parts and one of the tags, Form F, shown on the preceding page.

When the stock thus required consists of resistance parts for controllers, it is issued on the card Form G, which, being printed, prevents the mistakes and omissions that would often occur where so many small parts are used, and it also saves considerable time.

Receiving Stock.—Raw stock is counted, checked, and weighed by the receiving clerk, who O K's the dray bill; this is then handed to the clerks in charge of raw stock and castings, who copy it on Form H, a simple memorandum sheet which is not shown. It is then recorded on Forms I and J; these forms show, in addition to the disposition and condition of that item, all necessary information for inventory, pricing, and buying purposes. The prices are corrected every two months.

It will be noted that Forms I and J show the standard order quantity and the low limit, and it is the duty of the receiving clerk to keep a close watch on the balance column and to write a requisition for the standard order-quantity as soon as any item falls below the low limit.

Issuing Stock to Shop.—When the store keeper gets his stock list, Form D, with a job card, Form A, he frequently finds it necessary, especially in bar stock, to issue more than is necessary; hence, for each item he returns an account on a "Stock Memorandum," Form K, not shown, (being a simple memorandum slip of job number, stock, and quantity); this goes to the receiving clerk, who records it on Forms I or J, and all K-cards for one job are filed in an envelope bearing the job number, and ultimately the date of completion (Form M, not shown). Finished parts required are accounted for on a "Finished Stock Memorandum" slip, Form O, not shown, similar to Form K, but white instead of yellow, and also filed in M. All unused stock returned is accounted for on a blue "Credit Memorandum" slip, of the same shape as D and O and similarly ruled. (Form L, not shown) and filed in Form M. Borings and other scrap are also accounted for on this credit memorandum and the current value of such scrap is used in figuring the material cost of the job.

Casting Pat. No. 2219. Brass List No. V 310

OLD CARD PRICE B6810 20 lb. ORDER QUANTITY 500 LOW LIMIT 300

RECEIVED				GIVEN OUT				BALANCE	
Date	FROM	Quantity	Weight	Date	Quantity	Weight	Job No.	Quantity	Weight
1/1/06	Inv	500	500#	1/5	500	500	#7750	—	—
1/15	OK Brass Co	500	500					500	500

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FORM J. STOCK CARD FOR RECORD OF ITEMS RECEIVED.
Original is 5 by 8 inches.

OLD CARD NO. AG815 LABOR 5.75 HOURS 20.75 LIST NO. Q 217 HIGH LIMIT 200
EXPENSE 4.28
BOX NO. 16 MATERIAL 2.00 COST 13.03 DRAWING NO. 2216 LOW LIMIT 100

RECEIVED			GIVEN OUT				GIVEN OUT			
DATE	QUANTITY	JOB NO.	DATE	QUANTITY	JOB NO.	BALANCE	DATE	QUANTITY	JOB NO.	BALANCE
1/16	Trns 100		1/17	150	5599	150				
1/15	200	5510								

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FORM P. RECORD OF FINISHED STOCK RECEIVED.
Original is 6 by 4 inches.

Stock so credited back is restored to stock cards, Form I or J.

When completed the job is received by the store keeper and accounted for on a pink "Finished Stock Received" slip, Form N, not shown, but again like K, L, and O, except as to color; it is then entered on Form P, which card it will be noted shows the cost properly divided, the location in the store room, and also a low limit and

PART V 154 A MACHINE Assembled Arm Drg. 447

DATE	JOB NO.	NO. PIECES	TOTAL MATERIAL COST	HOURS LABOR	LABOR COST	EX. RATE	FAC. EXPENSE	TOTAL FACTORY COST	FACTORY COST PER PIECE
2/3/06	5510	50	384 25	200	50 00	,15	30 00	464 25	9 285

The Engineering Magazine

FORM Q. PERMANENT RECORD OF COSTS.
Original is 8 by 5 inches.

order quantity which is used in the same manner as described above for raw stock.

It will be evident that if the low limits and quantities have been properly proportioned, the quantity of stock on hand will remain at a practically constant level.

It frequently happens that when the requisition (R) for raw stock or for a job card to make up finished parts comes to the purchasing agent, he will have reason to lower or raise the order quantity and if he means the change to be permanent he will order it noted on the proper record cards.

When the job is completed, all the slips, Forms K, L, N, and O, are taken from Form M and used to check up and correct, if neces-

JOB CARDS
~~MATERIAL~~ } Wanted for the following: Date, 12-30/06

Article Arms
List No. V159A Drg. No. 447
Pat. No. —
Material —
On hand 6
Order Quantity 50
Low limit 50
Job issued 6810
Ordered — O.K. S

The Engineering Magazine

FORM R. REQUISITION FOR STOCK OR FINISHED PARTS.

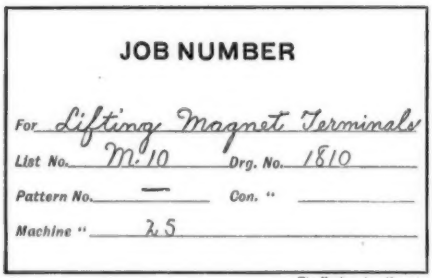
sary, the list on Form C. The cost of the various parts, including labor cost and shop expense, are now extended; the cost of assembling is added, and permanent record is made on Form Q, which usually contains the record of the cost of former lots and hence affords instant comparison, which occasionally leads to the detection of error.

Form Q is filed for ready reference under the list-number of the part, and is frequently referred to for monthly and yearly averages. Duplicates of this form, showing the yearly average costs, are furnished to the sales department and to the estimating department.

Order Quantity and Low Limit.—When any piece of apparatus has been thoroughly developed and is ready to be added to our list of standard products, the sales department is asked to estimate the probable average monthly sales for the first year and with this as a basis

the order quantities and low limits on all raw stock, finished parts, and assembled parts required, are determined at a conference between the purchasing agent, superintendent, and the superintendent of production.

The requisition, mentioned above, for stock or for finished parts, is special, as shown From R. It is evident that there has been an excessive drain on this item which will probably lead to a temporary or permanent raise in the order quantity.


JOB NUMBER

For Lifting Magnet Terminals

List No. M.10 Drg. No. 1810

Pattern No. — Con. "

Machine " 2.5

The Engineering Magazine

FORM S. STORE KEEPER'S REQUISITION TO PURCHASING AGENT FOR LOW STOCK.

When job cards are issued for assembled parts which have fallen below the limit, finished parts and stock are issued and these in turn fall below the low limit and must be ordered, causing raw stock to fall below the limit and a new lot to be ordered. When all these operations are completed, we have in stock, for example, 50 assembled controller arms, finished parts for 50 arms, and enough castings and raw stock to make finished parts for 50 more arms. The scheme is designed to allow for the use of the assembled parts made last month on machines to be delivered in the current month; to assemble parts for use next month, machine parts for parts to be assembled next month, and to buy raw stock for parts to be machined next month.

The system requires considerably more outlay for stock than do hand-to-mouth methods, and therefore good judgment must be exercised in estimating probable sales and also in establishing the necessary limits from the basis thus given. It makes possible, however, a great increase in output per operative and per square foot of manufacturing space available. It also relieves the purchasing agent, superintendent, and all concerned of much unnecessary worry, and it makes it possible to live up to promised deliveries and thus materially aids the sales department.

For parts on which regular limits have not yet been set, the store keeper is expected to watch the stock and when low to requisition the purchasing agent on Form S.

Storage of Stock. This company moved into its present quarters

in 1902. The space for office and shop was rented from the Wellman-Seaver-Morgan Co. Since then our output has more than trebled, and it has not been possible to expand the available space at the same rate. The W. S. M. Co. built a large office building and our general offices and drafting room secured space in it; later, we were compelled to put up a separate building for shipping and storage purposes, and finally we secured space to remove the tool room from the general shop floor, and still we find ourselves crowded to the limit and are compelled to make the best possible use of every available inch of space.

This company manufactures a number of types of controllers, brakes, lifting magnets, magnetic switches, magnetic solenoids, etc., and each type is built in several different frames to accommodate the various sizes of motors. All apparatus is necessarily subject to improvement; hence there are generally two and in some cases three styles of each type.

Controllers and magnetic switches especially involve the use of numerous small parts, and it is our practice to keep constantly in stock renewal and spare parts for all apparatus sold, even for apparatus whose sale has long been discontinued.

The storage of such parts, together with that of parts and raw stock for apparatus now manufactured, so that each is instantly available, involves a rather elaborate system of bins, drawers, racks, etc, and the first cut shown, Figure 1, hardly justifies my remark regarding instant availability.

That photograph, however, was taken about a year ago and since then we have learned how to make much better use of space, as I think Figures 2 and 3 will demonstrate.

In Figure 1, at the extreme left shows just the corner of a large case of small drawers for screws, nuts, small rivets, washers and similar small stock. The rack for reels of wire of all sizes is in the left background. Reels of wire can be taken from or replaced on this rack readily by means of the rope hoist attached to a small trolley carried along the top of the rack.

In the central background is shown a structural-iron rack for metal drawers of various sizes, generally used for small finished and assembled parts. There are four tiers of these boxes, each served by a traveling step-ladder which makes all this stock instantly available.

Each drawer is marked with a label, giving the list number, name, and the high and low limits for the piece. This latter precaution sometimes enables the store keeper to warn the stock clerks of a

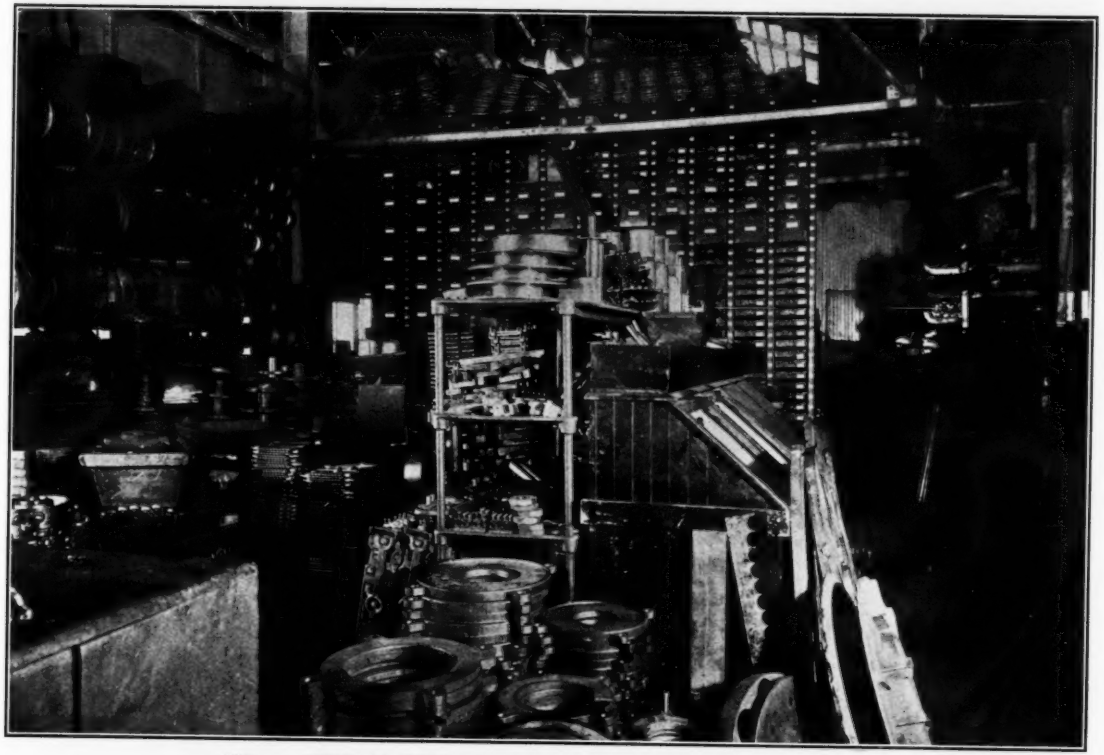


FIG. 1. GENERAL VIEW OF STORE ROOM. FORMER ARRANGEMENT.

At the left shows the corner of a case of small drawers for small parts; rack for reels of wire in left background. Structural-iron rack of drawers for small and assembled parts shows in central background. In the center, oil cabinet and rack for miscellaneous small articles.

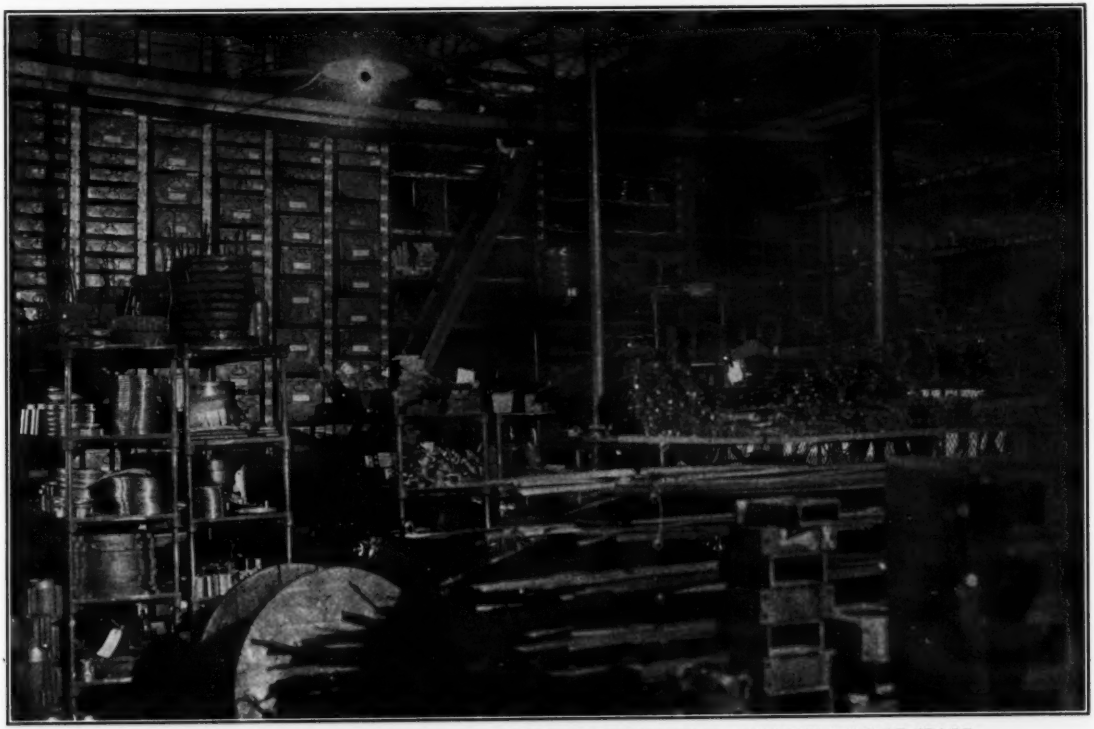


FIG. 2. ANOTHER VIEW OF THE STORE ROOM, WITH MODIFIED ARRANGEMENT OF SPACE.

In the left background, a second rack for metal drawers, arranged with large deep shelves at one end for sheet insulating stock. Racks for miscellaneous stock in center. Tree rack for bar stock in right foreground.

FIG. 3. A FURTHER VIEW OF THE STORE-ROOM ARRANGEMENTS.

The rack in the left background is designed for the shop stock pans described on the facing page and shown in detail on page 230. The bins on the right store about 20 tons of cast resistance grids, properly classified. Small castings piled in rows in the foreground are the heaviest stores carried.

shortage which they have overlooked, especially in parts not often used.

At the right of Figure 1 is the rack, consisting of long pigeon holes open at both ends, for Bar Stock. In the center is the oil cabinet and a rack made of cast-iron shelves for miscellaneous small articles, mostly for special jobs and therefore not carried in sufficient quantity to warrant assignment to a special space.

In the left background of Figure 2 is a second rack for metal drawers, arranged at one end with large deep shelves used principally for sheet insulating stock, such as fibre, asbestos, mica, hard rubber, fuller board, etc.

In the left foreground are more racks for miscellaneous stock.

The "E" coils 19 inches long for Dinkey ventilated controllers are stored in the rack at the right background, while under this rack, not visible, stands a wooden gridwork rack studded with about eighty long harness hooks and used for the storage of the small coils of special resistance wire.

In the right foreground is a tree rack for long flat stock.

The angle-iron rack for shop stock pans, shown in the left background of Figure 3, is part of a recently established system intended to reduce the amount of rehandling of parts to a minimum. The pans are made of sheet steel, measure about 12 by 20 inches at the top, and when full of small castings weigh about 150 pounds.

In the rack they rest on 1 inch by 1 inch angles, leg up, which fit the bottom loosely and thus permit of the pan being slid in or out easily. Just above the ordinary man's head is a walk reached by a step-ladder and used when handling stock in the upper rows. The heaviest stock is stored in the lower rows, the lightest in the upper rows.

This system, when complete, will consist of a number of these racks, each one carrying (small parts) stock, raw, finished, and assembled for a separate line of apparatus.

The set of bins at the right was designed to enable us to carry, properly classified as to sizes and styles, about twenty tons of cast resistance grids. The floor space occupied is twenty-four square feet which is easily less than one-fourth the space which would be required to carry such a stock, so classified, by piling the grids on the floor. There is a narrow walk, reached by a step-ladder, for handling the grids in the upper bins.

The small castings, piled in rows with aisles between, in the foreground of Figure 3, are the heaviest stock carried in the stock-room;

FIG. 4. RACKS WITH PANS FOR STOCK PARTS.
Carrying, in small space and conveniently assorted, all the pieces needed for the assembling of certain parts.

larger castings are delivered direct to the shop, a bad practice necessitated by our extremely limited storage space.

The pair of racks shown in Figure 4 are one of a number of such sets distributed about the shop. It will be noted that the pans are the same as those shown on the rack in Figure 3. This set of pans contains all the different parts required for the assembling of a certain part, yet very little floor space is occupied by it.

It will be noted that throughout I have seemed to consider economy of space as the chief desideratum; but, while that is absolutely essential in our factory, orderly and effective system is our chief aim.

The neat and orderly appearance of the racks, shown in Figure 4, undoubtedly has a beneficial effect on the workmen and hence on the output. A well-housed, well-groomed horse will invariably give better service than another equally as good and as well fed, but lacking the first two essentials.

HIGH-SPEED STEEL IN THE FACTORY.

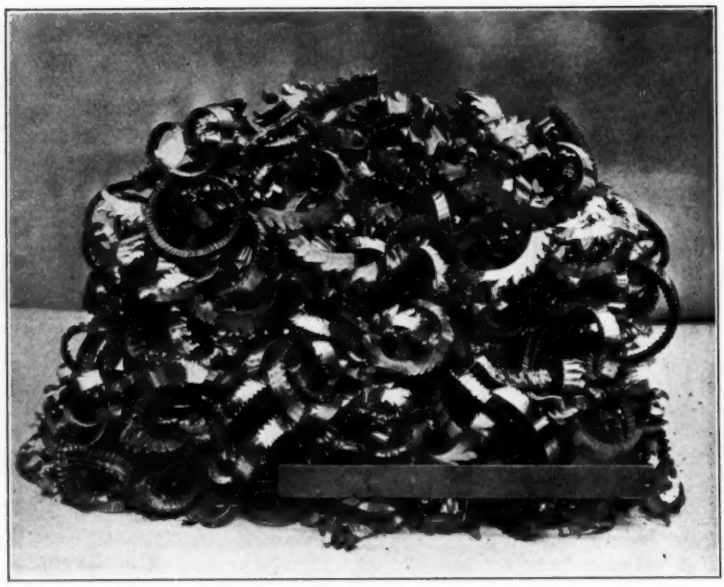
By O. M. Becker

V. THE RANGE OF ADAPTABILITY OF ALLOY-STEEL TOOLS.

Mr. Becker's discussion of this subject began in The Engineering Magazine for September, 1905, and extended in that series to a group of four articles, taking up successively the general outline of the problem, controlling principles in introducing the steel into the shop, working directions for the making of the tools, and the design and operation of tools and machines. In this supplementary series he will follow the present paper with two more; the next will deal with "The Tool at Work," and the following one thereafter with "Feeds and Speeds with the New Tool Steels."—THE EDITORS.

THE idea seems still to be rather widely prevalent that high-speed steel is adapted to but a small variety of uses—that its utility is chiefly confined to the heavy lathe and the removal of large quantities of metal by means of heavy cuts. The belief has been fostered, no doubt, by the widely spread reports of the performances and defects of the early and really experimental products put out by the pioneer manufacturers of these steels. There is no longer any reason for such a belief, for the new steels have been improved to such an extent, and the methods of treating them have been so perfected, that there is scarcely a use to which carbon steel is put in metal-working tools, where a high-speed tool will not do better work—provided, of course, the machine in which the tool is used is as well adapted to the latter as to the former. Obviously its greatest utility is in those processes where it is necessary to "slaughter stock," or in cutting material upon which an ordinary steel tool would be out of the question. There are, moreover, certain possibilities which have not heretofore been even thought of, as for instance, the machining of chilled gray iron, an operation now not only possible, but practicable and relatively economical.

Such operations, however, form but a small proportion of those performed in the average factory; and the real test of the utility of the new tool material is its economical applicability to the multitude of ordinary jobs for the doing of which carbon-steel tools have heretofore served very well. It is becoming more and more apparent that, even under the conditions involved in the use of machine tools designed to meet less strenuous requirements, high-speed tools must



CHIPS FROM LOCOMOTIVE TIRES, ANGUS SHOPS, CANADIAN PACIFIC RAILWAY.

The 12-inch rule gives the scale. The chips were turned in a 90-inch chucking lathe, two tools working with 5/16-inch feed and ½ to ¾-inch cut. An example of the work in which alloy-steel tools show their very highest efficiency.

eventually displace those of carbon steel, almost entirely. A certain evidence that the change is rapidly taking place is the greatly increased ratio of sales of high-speed tool material as compared with the ordinary carbon stock. So confident are some makers of alloy-steel in the general utility of their product, that they unqualifiedly guarantee to make tools to replace, at a saving, any carbon tool already in use. However much their confidence may be justified, it seems probable that within a few years at least eighty per cent of all jobs in machining iron or steel will be performed by high-speed-steel tools. Such a condition can come about only in consequence of a demonstrated superiority in quality or greater economy of output—a demonstration now well in process.

In many plants the change will of course be slow after those jobs have been taken care of in which the use of the new steel is so plainly indicated as to be practically unavoidable. Indeed, there are cases where the management of a plant is so short-sighted as actually

to discourage further use of high-speed tools. Competition will undoubtedly in time compel a larger use of these tools, even in such cases; and as existing equipment wears out and is replaced with heavier, capable of using them to something like their full capacity, their greater efficiency will become so obvious that it cannot be longer ignored.

Four considerations affect the efficiency of a tool: first cost, accuracy of work, cost of maintenance in an efficient state, and endurance. Many a tool user regards only the first, whereas it is not necessarily even the most important consideration. Frequently it is the least important. The total cost of all the items properly chargeable to the tool itself, per piece satisfactorily finished, is the only rational basis for making such a comparison. And considered on such a basis, the greater efficiency of the high-speed tool becomes manifest under practically all conditions and on nearly all jobs.

In the lathe, whether of the chucking or turret type, scarcely a job can be mentioned that is not done as well, at the least, as with a carbon tool, and at a considerable saving in the time required for grinding and setting up, even if there be no increase in cutting speed or amount of metal removed. Just how this occurs has already been pointed out and need not be here repeated. The objection formerly made that high-speed-steel tools were not suited to finishing cuts does not now hold. The grain of some brands, if not of all, is as close and the cut as smooth as could be desired. This being the case and the tool holder and the correspondingly inexpensive small-piece tool, (requiring practically no forging and needing little more than to be cut off and hardened) being available at ordinary speeds and cuts such as are taken with carbon-steel tools, the first cost of the tool becomes insignificant, and the saving in grinding and setting-up time is clear again—often no inconsiderable item, either.

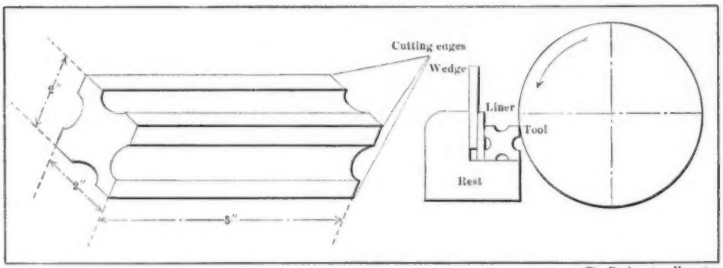
For illustration, take the following data, which may be duplicated in the essential features in almost any lathe job that might be mentioned:

Tool	Pcs. Finished per grinding.	Time for Grind. etc.	Total Pcs. Finished.	First Cost of Tool.	Cost of Time, per Hr.
Carbon	50	5 min.	1,000	$0.25	$0.20
High Speed	300	5 min.	10,000	0.75	0.20

The time lost in grinding and setting up figures out as costing 3.3 and .55 cents per hundred pieces for carbon and high-speed tool respectively; and in the same manner the first cost of tool comes out as 2.5 and .75 cents respectively per hundred pieces. Whence the total

cost of tool and tool maintenance, per hundred pieces finished, is for the carbon-steel tool 5.8 cents and for the high-speed tool only 1.3 cents. And all this without any change whatever in the speed or cut, the whole gain being the result of the greater endurance of the high-speed tool.

There is a growing disposition to use chilled rather than sand-molded castings for many purposes. The practical impossibility of machining such castings has heretofore prevented an extension of their use. Chilled rolls have indeed been turned with the very best of tools and at an extremely slow rate; but further than this little has been possible heretofore. With high-speed tools of proper form it is comparatively easy to machine rolls to a plane surface, and even to cut grooves and spirals. For this kind of work, however, the ordinary pointed tool will not do, and it is necessary to use a special form of cutter. The most satisfactory results are obtained with a tool having a long cutting face and an edge approximately of right-angle section. For the support of such a tool ordinary methods are, of course, not available, since it is impossible to obtain sufficient rigidity.



The Engineering Magazine

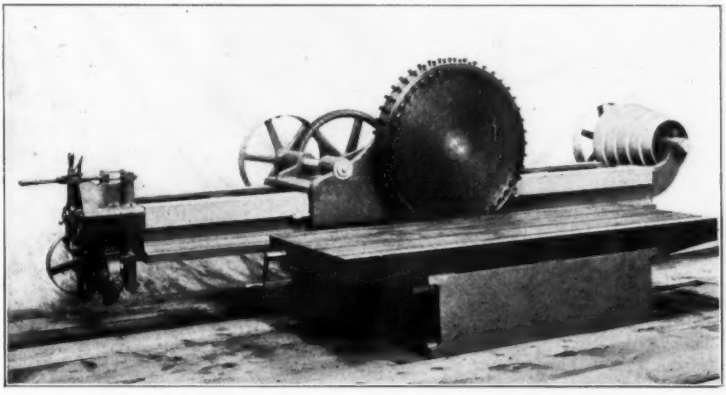
TOOL FOR CHILLED-ROLL TURNING, AND METHOD OF TURNING EMPLOYED.

The grooves in the tool reduce the amount of grinding necessary to renew the cutting edges. An ordinary tool rest is of no use; the tool is supported on a suitable rest bar and wedged (or screwed) against the roll. There is no forward feed.

A satisfactory method is to use a square bar of suitable length, say four or five inches, and one and one-half to two inches section, with grooves milled or planed into each side. This is ground so that the long edges are true and sharp, and properly hardened. The cut is taken by one of the long edges, the tool being held against the face of the roll by a special rest bar, the cutting edge slightly below the level of the axis of rotation. This tool is not fed along the face of the roll by the lead screw, but is pushed against it by screws or wedges, pre-

ferably the latter, until the required diameter is obtained. It is then moved and another section turned in the same manner. If care is taken it is not necessary to remove the tool for cooling, and it will stand a good deal of cutting without re-grinding.

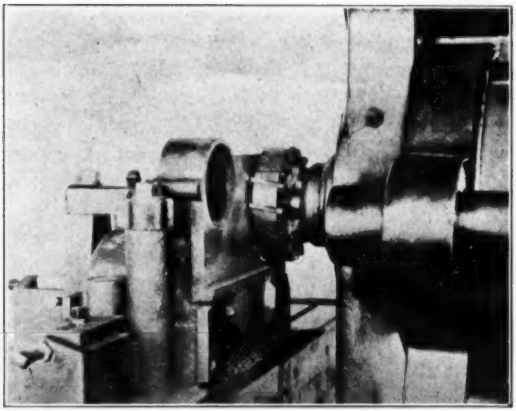
For grooving, the tool is ground at the end to just the form of the required groove and pushed against the roll in about the same way as in surfacing. The ordinary tool holder is quite useless, and the cutter is wedged into an arched holder and forced against the roll by wedges and screws, preferably the former.



A ROTARY PLANER. INSERTED ALLOY-STEEL CUTTERS.
A recent type of machine tool combining high efficiency with relatively low tool cost.
Wm. Sellers & Co., Phila.

The inherent weakness of all reciprocating machines is in the fact that they *do* reciprocate. The consequent loss of motion in stopping and starting again at the end of each stroke makes them relatively of greatly inferior inefficiency compared with machines working upon the rotary principle. It has been thought heretofore that the cutting speed of such machines as planers, shapers, and slotters could not be increased very considerably because of the jarring at each reversal—a belief pretty well founded in so far as it concerns machines of these types other than those of most recent design. Little thought has therefore been given to the question of applying high-speed tools to them.

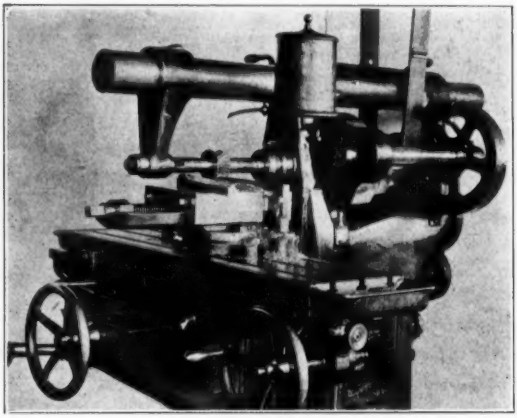
Of late, however, there have been some developments in this class of machines going to show that the high-speed tool is to have a larger place as a reciprocating cutter. Even if there were no important in-



AN 8-INCH INSERTED-TOOTH MILLING CUTTER AT WORK.

Facing off change-feed box, table feed of about 7 in. per minute. Becker-Brainard Milling Machine Co.

crease in the speed and power of such machines, the same reasons which make a high-speed tool desirable in a lathe even under ordinary conditions, apply to the planer and shaper tool, though possibly to a less extent. That is, the time saved in grinding is relatively of less consequence, because there is not a great deal of grinding to do anyway. The saving in cost of tool per piece machined, the only correct way of reckoning tool cost, however, corresponds to that shown in the case of lathe tools.



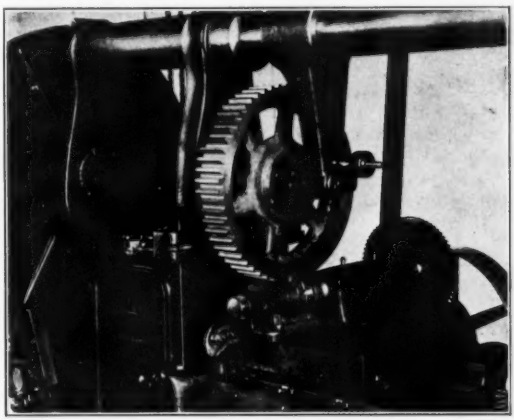
ONE PAIR ALLOY-STEEL 40-DEGREE ANGLE CUTTERS BEVELING TOOL-STEEL GEAR-CUTTER DOGS.

Table feed ¾ inch per minute. Becker-Brainard Milling Machine Co.

But the new rapid-stroke quick-return machines make it possible to increase considerably the speeds, and in most instances the feeds also; and thus require, in order to reach their highest efficiency, the high-speed tool. A recent demonstration showed

that it was entirely practical to plane steel forgings * in a 36-inch machine and under unusually difficult conditions, at the rate of 40 feet per minute, feed ¼ by ½ inch; and gray iron plates 12 by 23 inches have been regularly roughed in six minutes and smoothed in half that time. A 24-inch planer of the same design has been run at a speed and efficiency that has made it possible to reduce the labor cost on the job for which it is particularly used, from 30 to 8 cents per piece, increasing the former output of 9 to 12 per day to 40 to 55. A quadrupled efficiency is not to be expected in all cases; perhaps not even in many. But even so, a much less striking increase in efficiency would amply justify a change. A reduction of 50 per cent in planing time, as guaranteed by one maker, is certainly worth considering.

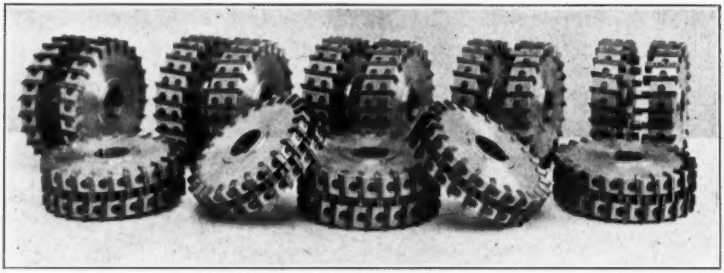
The evident tendency of the milling machine to replace the planer, shaper and slotter has been accentuated by the new tool steels, whose efficiency is not subject to the same limitations in the form of a rotating tool as in the reciprocating form. All that has been said of pointed tools, with respect to their superior efficiency when of high-speed steel, holds true, to a greater extent, even, of milling cutters. The grinding of most such cutters, however, is of necessity carried on in the tool room where it may be done with the required degree of accuracy, and is therefore more expensive than in the case of the simpler tools. The most important gain, however, is in the greatly increased feed allowable when high-speed tools are used. It is true that an increase in speed is also possible; and while advantage is taken of this circumstance, the best practice now indicates increased feed rather than greater cutting speed so far as



A 36-INCH AUTOMATIC GEAR CUTTER CUTTING CAST-IRON SPUR GEAR.

Time about 2 hours, completing the whole gear. Becker-Brainard Milling Machine Co.

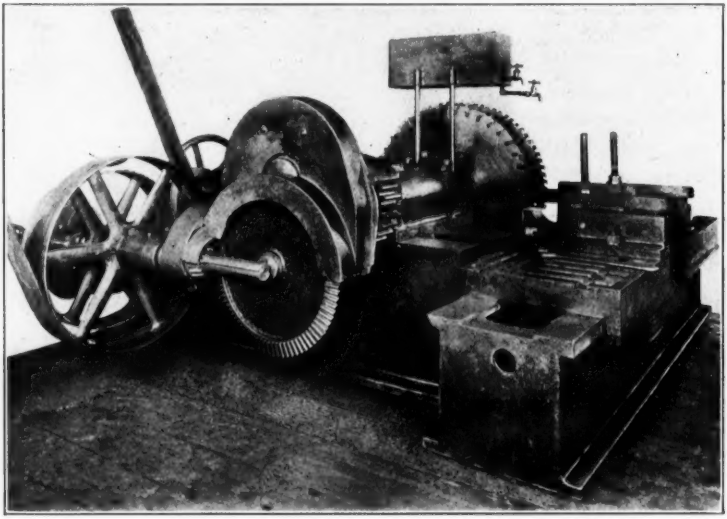
* Test of their new design of planers, at the works of the Chandler Planer Company, Ayer, Mass.



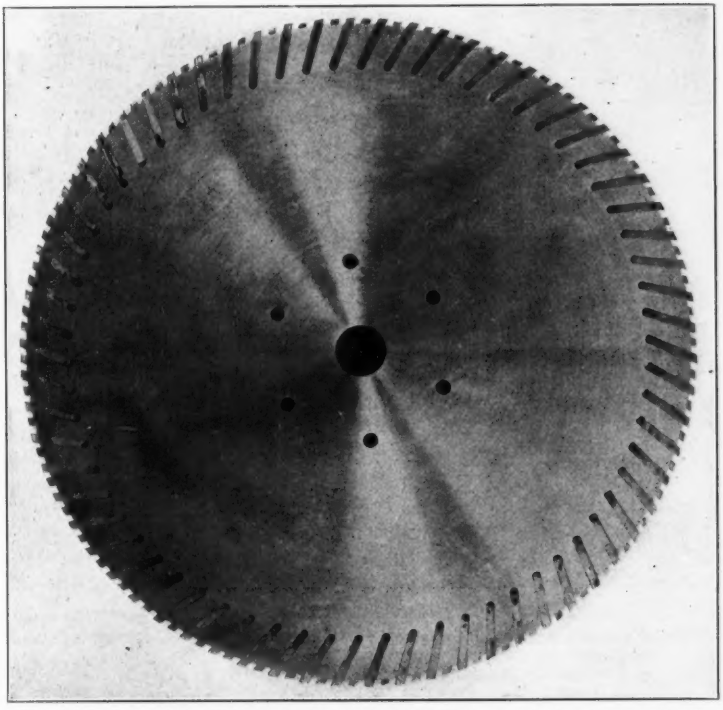
A GROUP OF INSERTED-TOOTH CUTTERS.
Brown & Sharpe Mfg. Co.

milling operations are concerned, whether it be upon castings, forgings, or other materials. On this account it is in most cases advisable that the clearance of the cutting teeth also be increased by the use of fewer of them.

The design of these tools has already been considered, and it is unnecessary here to elaborate the former discussion. It may, however, be pointed out that for millers of relatively narrow cut-



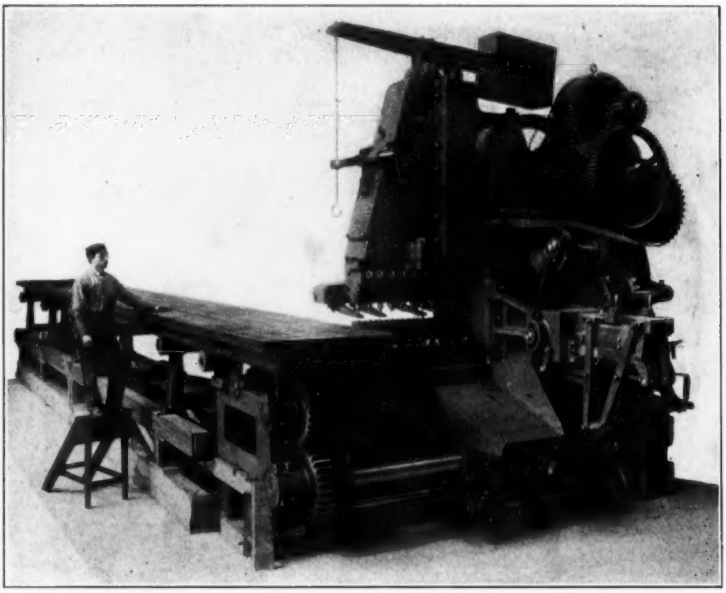
DOUBLE ROTARY SLOTTING MACHINE, WITH INSERTED ALLOY-STEEL CUTTERS.
High-Duty Saw & Tool Co., Eddystone, Pa



HIGH-DUTY INSERTED-TOOTH TINDEL SAW, FOR CUTTING STRUCTURAL STEEL SECTIONS AND RAILS.

ting face, inserted teeth allow the production of a comparatively inexpensive tool for all diameters over four inches. For smaller diameters it is necessary to use the solid tool, which somewhat increases the tool cost per piece.

A typical case showing the superior efficiency of high-speed milling cutters is here given. On gray-iron castings a 3½-inch cutter (18 spiral teeth) cuts at a surface speed of 82 feet per minute with a table travel of 27 inches per minute, and mills 6,800 linear inches at a grinding. The best results obtained with a carbon-steel cutter under the same conditions were 1,300 inches at a table feed of only 15 inches per minute. The carbon tool requires grinding once a day, at least, whereas the high-speed cutter runs five days, the former finishing rather less than 270 pieces per grinding, to the latter's 1,360 pieces. It was possible to reduce the labor cost per hundred from



A SUGGESTION OF ECONOMY IN USING ALLOY-STEEL PUNCHES.

Stopping a large gang punch to replace a broken or worn punch means a loss of time that might easily pay for the high-speed tool. The more the punches in the gang, the greater the proportionate loss of time. The large machine here shown is by Wm. Sellers & Co.

$1.40 to $1.10. Besides this there is the saving in the expense of grinding to the amount of $0.11 per hundred pieces, so that the entire saving is $0.41 per hundred pieces—enough to pay for the additional first cost of the tool in less than a week. Furthermore, the tool has an almost indefinite life, outlasting from five to twenty carbon tools, so that if considered merely with reference to the first cost and amount of work done, the high-speed cutter is from one-third to one-tenth as expensive as the carbon tool.

High-speed drills are undoubtedly as efficient on every class of work as are the other forms of cutters already considered, unless possibly in the smaller sizes. It may be questioned if there is any particular advantage over a carbon-steel drill in any size below quarter inch. There is not enough metal in the sizes smaller than this to stand the rough usage which may be freely given larger drills, and with speeds and feeds much increased there is likely to be con-

siderable breakage of drills. It is, nevertheless, true that striking results have been obtained from small-size drills, and they are made for sale down to ⅛-inch. Slightly annealed, so as to increase the toughness, a small drill rarely breaks, if used with reasonable care; and though it does not hold its edge as well as if harder, it invariably greatly outlasts a carbon drill. A ¼-inch drill has been run continuously at a rate of about 1,100 revolutions per minute with a feed of .008 per revolution, in ordinary mild steel, without breaking down; and in gray iron somewhat faster. The agreed rate for a carbon drill under similar conditions is about 220 revolutions per minute with a feed of about .005 per revolution. Stated in terms of peripheral speed the ratio is 826 to 176. The same ratio (about 4.5 to 1) holds good throughout the various sizes, whether large or small; and when it is remembered that the feed allowable is practically double that of the carbon drill, it is seen that the amount of metal removed in a given time is in the ratio of 10 to 1, approximately. This looks big, very big; but in practice the labor rate is largely dependent upon the time lost in handling the piece and in keeping the tool in a state of efficiency; so that in operations involving the boring of shallow holes, where the working time of the tool is short compared with that required for changing the piece, the chief gain is in the time saved in taking care of the tool and in its greater life. When, however, holes are of any considerable depth, so that the cutting time becomes the chief factor, the saving is likely to amount to considerable.

Multiple-lipped drills, rose-reamers, and similar boring tools are in the same category as the double-lipped twist drills, in this respect. There is, however, at least one consideration which differentiates them. The latter, employed mainly in enlarging and truing holes already existing, take a thin chip, with the peripheral part of the lip only, so that the tendency is to wear the outer angle of the tool and reduce the size—a process that proceeds in an increasing ratio when once started, and necessitates careful watch in order that the tool may be kept well ground and in size. The advantage of a tool that will hold its cutting edge for a long time under such circumstances is apparent. In the larger sizes of rose reamers, which take considerable time for grinding, the advantage is still greater. In these sizes, too, say those above a 2-inch diameter, the first cost need not be greatly in excess of that of a less efficient tool, because the inserted-cutter tool may be used. As has been previously pointed out, in case a reamer whose cutting blades are held by mechanical means rather than by brazing can be used, and the cost of the holder distributed

over several sets of cutters, the first cost of the tool becomes actually less than that of an ordinary carbon tool.

The discussion of reamers and drills reminds one of the stock joke of the man who bought a high-speed bit to use in a ratchet drill, and complained of his results. The joke has lost its point, for mechanics are getting into the habit of buying high-speed drills, taper reamers, and other tools of similar kind, for their kits, finding that it pays to use them in preference to the old kind. So also with hand reamers, especially when used for accurate sizing. Their life is limited to the time they retain their accuracy. What profits it, therefore, to use a carbon tool at half the cost, when the life of a high-speed tool is ten times as great?

The same considerations which affect small drills likewise affect small taps and thread-cutting dies. If left hard enough to get the highest efficiency, the small cutting edges are too brittle to stand up, and easily crumble away. Proper annealing, however, entirely obviates this difficulty, though of course the cutting speed and the life of a grinding are somewhat reduced. Taps as small as 5/16-inch have been used under these conditions at an efficiency eleven times that of the highest previously attained; and in practically all cases the same ratio of increased efficiency is developed as in other classes of cutting tools. Thus, to give another typical illustration, a high-speed die regularly threads 1-inch bolts at the rate of about 20,000 per grinding, against 7,000 under former conditions—a saving that in a short time more than covers the original cost of the tool.

It is perhaps unnecessary to consider at length that variety of other cutting tools which includes hollow mills, boring-machine tools, and the like. They are for the most part comparable in their action and efficiency with lathe and planer tools, and are affected by about the same considerations as the latter. There is, however, one other form of cutting tool that deserves notice, namely, the cutting-off saw. Between the hack-saw blade of old and the best cutting-off saw made previous to the application of high-speed steel there is a difference, to be sure. But all these have been lamentably inefficient. The high-speed cutter, as now made, permits a bar of metal to be cut off, not as if it were wood, of course, but at a rate that is somewhat in keeping with modern expedition. Thus far, little use has been made of thin-bladed saws for high-speed cutting, ordinary milling cutters of three-sixteenth or one-quarter-inch thickness being mostly used. Even these have been unobtainable in diameters above 9 inches, and their usefulness has therefore been rather limited.

Plates as thin as ⅛ inch and in larger diameters are now available, and will, no doubt, completely displace carbon circular saws for metal cutting.

The inserted cutter idea is peculiarly applicable to metal saws of large diameter, such as are coming into use for slotting. For this purpose a new type of machine tool is being developed which bids fair to find an important place in the metal-working industries. A recent machine of this type operates two saws of 73 inches in diameter, cutting 1 5-16-inch slots.

There has apparently been so little experience in the use of the alloy steels for the blades of cutting-off shears and similar tools that little can as yet be said in reference to the economy of their use as compared with carbon blades. It is scarcely necessary to repeat what has been already said and what is also quite obvious—namely, that any economy effected by such tools is almost entirely the result of their longer life and the lessened need for grinding. In the case of punches the difference is very well marked, as well with respect to those used for punching holes as those used in blanking forms.

The ordinary punch, as is well known, usually gives out by collapsing or breaking off after the edge has become somewhat dulled. The increasing force required to drive the punch through the metal rapidly increases the molecular fatigue or intensifies already existing internal strains until the endurance limit is reached. The limit in high-speed steel is not very well established, but is certainly much beyond that of carbon steel of the best kind. Objection has been made to high-speed punches that, like drills, they are too brittle. The same answer however applies, namely, that proper annealing, to give the requisite toughness, obviates the danger of breakage, or reduces it to a minimum. Small-size punches, however, if working through thick, high-carbon steel, are difficult to temper to just the point at which they will have the required hardness and at the same time be tough enough to stand up. For this kind of work, where the holes are under, say ½-inch, the results with carbon punches seem to be about as satisfactory as can be obtained with high-speed tools, unless the stock is relatively thin. But in all the larger sizes, and in the case of tools for broaching holes in malleable iron, there can be no mistaking the higher efficiency of high-speed punches. A ⅞-inch punch, for instance, punches about 56,000 holes in a ⅜-inch channel iron. The life of a carbon steel punch is about 6,000 holes. This is in the ratio, approximately, of nine to one, a ratio which holds good for nearly all punching operations except as already pointed out.

In the case of blanking dies the question is not one of breakage, but of holding a clean and sharp shearing edge. Such a die made of high-speed steel, or faced with it, will do this almost indefinitely. For the blanking of large forms there is no necessity for using the high-priced material for backing; it is sufficient that the cutting faces be of high-speed steel, and solidly brazed to the backing, which latter may be of machinery steel if desired. The expense of making such a tool is little greater than if it were of the ordinary type—often it is considerably less. It of course depends upon the form of the die and the work it is to do.

The displacement of small castings by formed steel pieces has been growing apace since the advent of low-carbon sheet steels working easily in the forming die; and the press-working of sheet metals has come to be a distinct and important branch of metal working. The dies for operations of this sort are generally expensive because they must be accurate within very narrow limits. In making all but the simplest forms, the wear on some parts of the dies is very great, and they soon become worthless because they are no longer accurate enough for the work required. Hardening the faces of such dies has been resorted to with some success. But even the hardest carbon-steel forming blocks have a comparatively short life. A high-speed steel die, of course, costs a great deal more, especially if large, than the other. Its life, however, is so much longer that it much more than compensates for the greater first cost. It is to be remembered that in all such dies the prinicpal item in their cost is not material, but labor; and only in exceptional instances is material cost of relative importance.

Even this additional cost may be avoided in part by the use of inlays of high-speed steel, brazed to the face of the die, in such places as are particularly subject to wear. Such dies last about as well as the solid ones.

Even in the forge shop high-speed steel is coming to claim an important place. Much that has been said of sheet-metal forming dies applies to drop dies also; and it is found cheaper to pay more in first cost of die material than to pay for the renewals of the tool that would be required. In the heading machine especially is the high-speed die desirable. The excessive wear upon such dies, and in the case of hot pressing, the liability to drawing the temper and still further reducing the life, suggests the advisability of discarding entirely the carbon dies in favor of the high-speed ones. The one exception seems to be that of the cold heading die where the pressure

required is so great as to split the block when made of alloy steel. This happens commonly when heading particularly tough stock; and though quickly worn out, the carbon-steel die does not usually split as readily as the harder high-speed one.

In all cases, however, where tremendous pressures are unnecessary, the latter is greatly to be preferred. Take wire drawing, and other cold-drawing dies, for example. One of the chief difficulties always has been to maintain a uniformity in the size of the drawn rod or wire. If the exactness of size is important and the material exceptionally hard, the question becomes a very serious one. The answer is, high-speed steel for such dies. The life of the latter has been in some cases thirty times that of the best carbon-steel dies. The same is true of snap dies used for riveting. It remains to be demonstrated, however, that high-speed steel is superior to the best chisel steel for snaps and cutters in rapid-blow pneumatic tools.

Is it recommended, then, that alloy steel be used for all sorts of jobs and all classes of operations upon metals? Yes, practically all. As has been frequently pointed out in the preceding pages, in most jobs aside from those involving the paring principle, there is little, if any, increase in speed to be looked for. The gain is found mostly in the greater life of the tool and the reduced cost of maintenance. And though there may be no reduction in the labor cost of a particular product, the saving in the tool room alone is sufficient to justify the change. Any such saving, however—and, indeed, any considerable saving in the use of high-speed-steel tools in any operation—is predicated upon properly made tools. Many a manager or foreman has been unable to discover any advantage in the use of such a tool merely because it had been improperly made by men unskilled in the manipulation of the alloy steels. Common sense would indicate the need of careful attention to this point, for it is usually more important in determining the efficiency of a tool than any other single element.

In the discussion thus far, it has been assumed that high-speed steel is adapted to metal-working tools only. This is the general impression, and it may surprise many to be told that the new steels are finding favor as materials for wood-cutting tools. So far as is now known to me there has been no general disposition to make use of them for this purpose. Experience has shown, however, that high-speed cutters working on wood have in many cases a distinct advantage over ordinary cutters. A certain manufacturer of wood planers has taken advantage of this fact to market his machines

equipped with high-speed cutters, which he advertises as of a special steel not obtainable from the makers of other machines of the kind—an advertisement quite true unless other makers of wood-working machinery have also discovered the utility of the alloy steels and now make use of it for the same purpose. However that may be, it is certain that some managers of wood-working plants are finding out that high-speed steel is a good thing for them, and are making increasing use of it. Not only are planer knives, but forming knives, back knives, and, in fact, all sorts of cutters made of alloy steel. Even circular saws are used by certain enthusiastic discoverers in this new field opened to these wonderful steels.

An example of what is possible in wood working with alloy-steel tools will no doubt be of interest. In a certain job, cutting dowels from hard maple sticks, the ordinary cutter could not be made to work longer than half an hour at one honing; and even then, it was necessary to set it up several times in order to get the dowels properly sized. A cutter of high-speed steel easily runs thirty hours, and at the end of that time is in such good state that it would doubtless run as much longer without needing to be set up to preserve the required degree of accuracy. This is an efficiency of at least sixty to one, as compared with the old knife, and is typical of wood-cutting jobs in general.

It is, perhaps, too early to make any general predictions as to the extent to which the new steels will be found suited to this kind of work. But it is quite certain that for cutting hard woods at any rate, the field is wide open with all experience favorable to an extensive use. And while as yet these steels have had no large part in the wood-working industries, it is not beyond the possibilities that they will before very long practically displace carbon-steel here as they are doing in the metal industries.

MECHANICAL REFRIGERATION AND ITS FUTURE DEVELOPMENT.

By Joseph H. Hart, Ph.D.

Dr. Hart uses the interesting method of analogy in studying the refrigerating machine by the light of our fuller and wider knowledge of the steam engine. Each, he points out, is the converse of the other; therefore the principles established in the older field may profitably be extended for our guidance in the cultivation of the newer one. He makes it clear that this idea has a very practical bearing on the future of the refrigerating industry. —THE EDITORS.

MANY an engineer, at some time or other, observing the steam engine and ammonia compressor at work side by side in a refrigerating plant, has permitted his imagination to wander into more or less indefinite speculations on the analogy between the two, and the almost self-evident reversibility of action of one of the machines in comparison with the other. The extent and quality of such speculation will depend largely on the training and knowledge of the observer; to a steam specialist or a compressor designer, the analogy would be much clearer and extend further, but it could only appear complete to the specialist in engineering physics.

Such an analogy (or rather antithesis) in the action of the steam engine and compressor not only exists, and is of great interest, but a comparison of the entire heat theory with corresponding refrigeration conditions shows an almost perfect analogue, and a study of this promotes a much clearer understanding of both steam and refrigeration plants. It also serves the further purpose, that in pointing out the difficulties and errors and the line of true development in the production of heat and power, one can, by analogy, invariably arrive at the solution of corresponding problems in the theory of refrigeration. In addition, advances in the first-mentioned field are almost immediately followed by a similar development in the other; and today we have a number of improvements in heat processes which must sooner or later find their way into refrigeration. Under the circumstances, a close and systematic study of this analogy cannot fail to be of the greatest interest and conducive of good results, if only in pointing out the lines of least resistance for future development in experimental work in refrigeration.

The analogy extends throughout the whole range in the theory of heat. The generally accepted view in regard to the nature of heat is that it is the kinetic energy of the molecules. When a body gets hotter it is believed that the chief change is simply an increase in the average kinetic energy of these molecules; when a body gets colder— that is, when refrigeration occurs, either naturally or artificially—the molecules lose naturally or are deprived of their kinetic energy and the average energy becomes lower. This explains the connection between heat and work, and shows that when a body does work, the energy is taken from this source and the body gets colder; and also that by doing work on a body, the quantity of heat in it may be materially increased from this source of energy, as is evidenced by its rise in temperature. This phase of the theory is the working principle back of many steam engines and of the Bell-Coleman and the Allen dense-air refrigerating machines, and shows a marked and simple antithesis right at the beginning of the entire theory.

If we do not limit our definition of refrigeration to cooling from atmospheric temperatures, but regard it in the general sense of cooling at any temperature to a lower temperature, the analogy between the entire heat theory and corresponding refrigeration conditions becomes perfect. While the principle of reversibility exists in every case, in some only the heating side has developed its practical significance, and in others only the refrigerating end has received practical attention; but wherever and however heat is developed or used, we can reasonably look for the reverse case, that of heat absorbed or used for refrigeration.

Heat is given out or absorbed today in chemical reactions, in change of state, in work transformations, in electrical phenomena, and in the dissociation of atoms, as in radium. We have every reason to believe that all, and we know that most, of these actions are reversible; that is, heat can be given out or absorbed in any one of them, and refrigeration occurs when heat is absorbed or disappears as sensible heat, since this means a fall in temperature unless this heat is supplied from another source. Thus, in chemical reactions, steam can be dissociated at a very high temperature, and in so doing it absorbs heat and would cool off the mass, if heat were not constantly supplied from a furnace. This heat can be readily obtained again by exploding the two gases at a lower temperature. This actually occurs in the production of water gas, and the process is in reality a refrigerating machine and cools the coals in the furnace. In the

same sense, iron in its production in a blast furnace is also a refrigerating machine. An electric current, in what is known as the Thompson effect, produces heat or cold in a metallic junction depending on the direction of the current. Radium in dissociating gives out an immense quantity of heat and we have every reason to believe the process is reversible. A steam engine in cooling off the steam in the cylinder by doing work is a refrigerating machine as much as the machines built for that purpose. The processes of chemical reactions, electrical effects, dissociation of atoms, etc., are at present purely physical processes and offer no hope of practical development in the restricted sense of refrigeration from atmospheric temperatures, although a partial utilization of the heat of chemical combinations, in a form known as "heat of solution," has been made to a limited extent, both for heating and refrigeration. Sulphuric acid or an alkaline metal disolved in water produces an intense heat, so great that it has been used for making steam for power purposes. In the same way, salt disolved in water absorbs heat and produces a mild cooling effect.

The two remaining methods of heat production, namely, change of state and transformation of work into heat, are readily reversible under almost all conditions and are utilized in some form or another in the majority of the practical developments in this field. Steam heating owes its efficiency to the fact that steam in condensing gives out its latent heat of vaporization in the form of sensible heat. All freezing mixtures, such as ice and salt, owe whatever efficiency they may possess to the fact that the ice melts and in so doing absorbs its latent heat of liquefaction from surrounding bodies. All matter, gaseous, liquid, and solid, gives out or absorbs heat in a change from any one of these states to any other. In general, solids absorb heat when liquefied, and liquids absorb heat when vaporized, and the process is reversible. In all cases these two phenomena are coincident. Heat is always a by-product or an ingredient in a change-of-state transformation. If heat is furnished or absorbed in sufficient quantity, change of state always occurs. If change of state can be produced by artificial or natural means, heat is always produced or absorbed. According to the kinetic theory, the kinetic energy of the molecules is transformed into molecular potential energy, or vice versa; but whatever the explanation, this fact is the basis of the steam engine and the most successful refrigerating machines. In the one, vaporization is produced by furnishing heat to a liquid, in the other cold is produced by absorbing the heat required for vaporization. The ammonia machine produces cold solely by the vaporization of am-

monia liquid. The vacuum machine absorbs both sensible heat and latent heat of solidification from water by vaporization of water.

Liquids which are volatile at atmospheric temperatures and available pressures must, after vaporization, be reliquefied by cooling and pressure and used in a closed cycle. Increase of pressure means work to be done, so that in both steam engine and refrigerating machine two factors enter, heat and work. In the steam engine, heat flows from a high temperature to a lower one and work is given out. In the refrigerating machine work is put in, and heat made apparently to flow from a low temperature to a high one and thus further lower the low temperature. The vaporization of the liquid, in both cases, is merely one of the instruments by which the process is accomplished. In fact, it is only a more efficient tool and either process can be readily carried out with any permanent gas, such as air. In the first case, the most typical example is the Diesel engine, and in the case of refrigeration, that of direct cooling of air by making it do work. They are both almost true Carnot cycles, one in one direction and the other in the reverse direction.

A close comparison of the two processes at this point shows surprising conclusions. In order to see this yet more clearly, we cannot do better than to employ an analogy quite common in thermodynamics and explain its symbolic significance step by step as we progress. It is a common idea in the treatment of the subject of heat to regard it in the nature of a substance or fluid, and usually water is taken as representative. This concept is obvious and often almost necessary to many people in their treatment of the subject. Temperature is considered as water level, the height being always directly proportional to the absolute temperature, and the force which tends to pull the water to the lower level is the entropy. The analogy is perfect. Work done in the case of raising water is the force of gravity times the height; in the case of heat, the work done is the entropy times the rise in temperature. Water at a high level can be used to get work by letting it fall to a lower level, with a proper mechanism; but the amount of work obtainable depends on the mechanism and the highest and lowest level of the water. In the case of heat, work is done by letting a quantity of heat sink from a higher temperature to a lower one through a proper mechanism, and the amount of work obtainable depends on the highest and lowest temperatures used and on the form of the mechanism. The working substance—air, steam, or ammonia—has its best analogy in a sponge which is used as a holder for the water to raise or lower it, and the arm that raises and

lowers and squeezes and soaks up the sponge is the steam engine or refrigerating machine, The furnace or source of heat in the steam engine is a leaky barrel filled with water and raised above the common water level. In the case of refrigeration, the cold-storage room is the leaky barrel sunk below the common water level and partly filled with water, and the water or heat is always in the first case leaking out from the boiler and in the second case, is always leaking into the cold-storage room. The sponge goes through four operations in a cycle in each case. It soaks up water in the barrel, it is then taken out to the common water level, it is then squeezed and the water removed, and it is taken back into the barrel and the process repeated. In the case of the steam engine or motor, the sponge soaks up water in the barrel, or the working substance soaks up heat in the boiler; the saturated, heavy sponge does work in falling to a lower water level, or the hot substance does work in going through the cylinder; the sponge is squeezed and the water escapes, or the steam goes into the condenser and the heat escapes; and last, the partially dry sponge is carried back to the barrel, or the water is taken into the boiler, and less work is done in lifting the sponge back and less work is done in forcing the water into the boiler. The cycle with the sponge is more nearly identical to the four operations in a Carnot cycle than to this one, and the four operations with the sponge are almost true analogues of the four transformations, two isothermal and two adiabatic, that occur in the Carnot cycle. In the case of refrigeration we can consider that the sponge soaks up water in the barrel or the ammonia liquid absorbs heat in the cold room; the sponge is lifted to the common water level and work done, or the ammonia goes through the compressor and work is done; the sponge is squeezed outside and water escapes, or ammonia goes to the condenser and loses its heat; and last, the partially dry sponge drops back into the barrel and can be made to do a little work from its weight, or the ammonia liquid goes back into the cold-storage room.

Strictly speaking, the analogy of the sponge is closer, when the working substance is a permanent gas, and the analogy can be extended much further without much profit by considering a condensable vapor and its liquid as a tin can and a sponge, the tin can or the liquid holding more water or heat and not leaking as readily and being more easily emptied; but the sponge analogy becomes startling when we compare its behavior in its cycle and the various losses encountered, with the working substance in the motor cylinder (or the compressor cylinder) in its cycle, with the various losses encountered in these cir-

cumstances. In the motor case, water is constantly leaking out of the sponge and falling without doing useful work and a portion may be squeezed out in handling and be drawn back if caught in time, but extra work is lost. In the cylinder, heat drips out of the working substance and it may be taken out and drawn in again in the cylinder condensation and re-evaporation. In the compressor cylinder a similar analogy holds for reheating, in that the sponge when squeezed dry at the top gets some water before it gets to level in sunken barrel.

Now if we ask ourselves why are water and ammonia the best working substances in heat motors and refrigerating machines, the answer is quite plain from analogy—that they are the best and most suitable sponges available for the purpose. What are the requirements in a suitable sponge? It should be capable of holding a lot of water, it should not leak readily, it should be easily squeezed, it should not be too large or too heavy itself to work. Translated, this means that a working substance should have high latent and specific heats; it should be capable of changing its temperature readily when work is done—that is, it should be a gas or capable of gaseous form at one stage; it should not be too large—that is, the working pressures should be medium and not change much with temperature; and the density should be high. Water and ammonia satisfy these requirements to a high degree for their respective temperatures and the only reason that water is not used as a refrigerating substance is that, as a sponge, its size and weight is inconvenient at that temperature—that is, its vapor pressure is very small and so is its density.

This brings us to an interesting question. What is the possibility of more suitable sponges or more suitable working substances being discovered for both motor and refrigeration work? As has been said before, it must be a sponge capable of holding much water and of giving it up readily. Water flows from a sponge only by difference of pressure; this is equivalent to a difference of water level, and this in the last analogy means a difference of temperature, so that heat can be taken from a working substance only by compressing it until it gets hotter than surrounding bodies. This is the equivalent of the isothermal change in a gas and the lifting and lowering of the sponge is the equivalent of the adiabatic changes. These changes are brought about by changes in volume and pressure, rapidly or slowly, and a gas or volatile vapor lends itself to these changes with less losses or extra work than any other substance. The use of a condensable vapor rather than a permanent one, means simply a cutting down in the

size of the sponge for a given water capacity. Hence we see that a working substance should be a vapor with its boiling point near the lowest temperature in the cycle, and should have a high specific heat and a high heat of vaporization, and should have a high vapor density but a very low coefficient of vapor-pressure increase. The latter statement is equivalent to saying that the sponge should not be heavy in itself.

Now the rules determining the latent heats of substances, or at least the empirical relations between these and the boiling points, molecular weights, vapor densities, are well known, and in order to have definite conditions satisfied in regard to one we must necessarily have similar definite conditions satisfied in regard to the other. For instance, the law known as Trouton's Law (named after its discoverer) is fairly general for all substances and says that the product of the latent heat into the molecular weight is always proportional to the absolute temperature at which the change of state occurs. This is the same as saying that the latent heat of vaporization times the molecular weight divided by the absolute boiling temperature is a constant for all substances, and this is nearly true in every case. Therefore if we make limiting conditions in regard to latent heat and boiling points, through a consideration of this law, we will get limiting conditions in regard to molecular weight. Thus for a given boiling point, the lower the molecular weight the higher will be the latent heat of vaporization. Thus for water, the molecular weight is 18, the latent heat 966, and the boiling point 373 degrees absolute. For ammonia, the molecular weight is 17, the latent heat is 586, and the boiling point 241 degrees absolute, and the constant in the two cases is approximately the same. The molecular weight must therefore be low, and ordinarily, the fact that a substance has a higher molecular weight than water is almost conclusive evidence that its latent heat is lower than that of water if its boiling point is not abnormal. Now the number of substances that possess low molecular weights and normal boiling points is very small indeed. All the natural gases have low molecular weights, but very low boiling points, and therefore the pressures of the gases are too high at normal temperatures. The liquids which have been used as working substances in heat motors and refrigerating machines comprise almost all the known liquids at all suitable for the purpose, and of all these, ammonia, when all the influencing factors are determined, has been integrated to give the highest efficiency. The only possibility of its being superseded is the discovery of some new substance, or the changing of mechanical con-

ditions so that some of the determining factors at present considered do not carry the same weight.

We have come now to the analogy of the purely mechanical parts of the motor and refrigerating machine, and those affecting the design of the mechanism. The furnace and the cold room, the boiler and the shell cooler, and the steam and ammonia condensers, serve the same purpose at different points in the cycles, and the engine and the compressor perform a directly opposite function in the two cases. Every little improvement in the steam finds its analogue in refrigeration. High pressures are more efficient but more troublesome in both cases. A wide pressure range makes for efficiency in steam-engine work, a low one in refrigeration. Triple expansion in steam and three-stage compressors increase the efficiency in each case for the same reason. Steam jacketing a cylinder to prevent initial condensation finds its analogue in water cooling the compressor to promote it. There exist similar cyclic flows of heat into and from the walls of the cylinders, with diminished efficiency in both cases. Superheating the steam finds its analogue in wet compression for ammonia. The analogue can be extended much further, and it becomes obvious that any improvement in steam engineering permits of a similar one in refrigeration. The advent of steam into the rotatory field with the steam turbine is but the precursor of similar work in compressors with corresponding effect on refrigeration. The development of the gas engine and the elimination of steam as a working substance is the forerunner of similar work in refrigeration, with the elimination of ammonia as the working substance.

The future refrigerating machine will probably be of this type. It will have a cycle similar in some respects to that of the Diesel motor and will utilize the heat of chemical combination, possibly combined with that of change of state. The direct utilization of electricity for this purpose offers an inviting field for research. The search for a more suitable substance than ammonia as a refrigerating agent is hopeless, I believe, as far as the utilization of the heat of change of state is concerned. Changes in mechanism are bound to come, and these will follow along similar lines to that developed in the best steam practice.

THE UNITED STATES COAL STRIKE AND ITS MEANING.

The negotiations in the coal strike in the United States are so subject to change from day to day that no attempt can be made here to present the situation from a news point of view. Mr. Saward brings out instead the fundamental facts and conditions in the industry, the relations of the soft and hard-coal fields to each other, the comparative quantity and disposition of their output, the basis upon which the operators and the miners have heretofore been working, and the points at issue in the strike of 1906. This will enable the reader not so closely familiar with the question to understand not only the position now reached, but the permanent relations of the various parties involved and the perennial sources of agitation which, whatever agreement may now be arrived at, may be expected to reassert their influences again in the future. The article is thus a valuable contribution to the permanent literature of the subject. — THE EDITORS.

THE month of April, 1906, has brought the American coal trade to the climax and a very considerable crisis, and it is therefore well to gather up the facts connected with the industry: they can be largely shown by statistics. The struggle that has been pending for months and has now come to an issue is between the labor organization known as the United Mine Workers of America and the owners and operators of the mines—both in the anthracite and in the bituminous fields of the United States.

The situation as of April 1, 1906, may be briefly summed up and stated thus: An agreement between the operators and the United Mine Workers engaged in mining in the competitive soft-coal producing districts of Ohio, Illinois, Indiana, and western Pennsylvania, was entered into in 1904 for a term of two years; a reduction of 5 cents a ton from the 1903 basis of 90 cents a ton for screened coal, passing over 1¼-inch screen, was to be the rate for the period up to April 1, 1906. At joint conventions held in February, 1906, the men asked for an advance of 12½ per cent over the existing basis. No result was had. A further joint convention, held in March, resulted in the miners granting permission for any operation to resume where the employees could get the 1903 basis—a restoration of the 5 cents a ton taken off in 1904.

In the anthracite industry, the award of the Roosevelt Strike Commission (made as a result of the long strike in 1902, which

award dated from April 1, 1903, and was to hold for a term of three years) also expired in April of this year. Thus the effect would be, if a general strike order were issued, that mining of all grades of coal in districts subservient to the United Mine Workers would stop on April 1, 1906. The men in the anthracite districts, through a committee appointed by the Shamokin Convention of December, 1905, prior to the date of expiration of the three-years' agreement, presented a number of claims—"suggestions"—for a renewed basis of operations from that date forward, which would materially enhance the cost of coal. The anthracite operators stood firmly for the continuance of the conditions which had existed during the preceding three years. While negotiations looking to a settlement were going on, and after several conferences of the two opposing forces, by committee, the president of the United Mine Workers, on March 29, issued an order to the employees in the anthracite region instructing them to cease work on Monday, April 2.

In the first instance it must be said that while the United Mine Workers do not control all the laboring people—that is, they are not all yet in the order—the suspension of those who are affiliated, in the States where they are strong, usually puts the others out of work. The union is particularly strong in Illinois, Indiana, Ohio, and in the western part of Pennsylvania, with a scattering of forces in other States. The list of membership is nearly 400,000, "in good standing," according to recent official figures given out.

The details are shown below:—

Pennsylvania;	
Anthracite, Districts 1, 7 and 9	80,490
Bituminous, Districts 2 and 5	59,526
Indiana;	
Block, District 8	2,411
Bituminous, District 11	12,603
Ohio; Bituminous, District 6	34,644
Washington; Bituminous, District 10	465
Illinois; Bituminous, District 12	51,478
Iowa; Bituminous, District 13	10,957
Kansas, Bituminous, District 14	9,019
Colorado; Bituminous, District 15	446
Maryland; Bituminous, District 16	246
West Virginia; Bituminous, District 17	6,155
British Columbia, Canada; Bituminous, District 18	2,269
Tennessee, Bituminous, District 19	3,156
Alabama; Bituminous, District 20	3,215
Indian Territory; Bituminous, District 21	12,530
Montana and Wyoming; Bituminous, District 22	1,883
Kentucky; Bituminous, District 23	2,942
Michigan; Bituminous, District 24	2,272
Missouri; Bituminous, District 25	7,809
Total	304,516

These would not all be included in the strike recently in force, by reason of the disagreement at Indianapolis, for the membership in the States involved in the Inter-State agreement is not 130,000 persons. The first joint convention, in February of this year, held at Indiana, ended in a deadlock, because the men wanted an advance of 12-½ per cent over what they had received in 1904-6, and the operators refused to give this, or even to offer a compromise of any kind. Then it was that a second effort was made to relieve an otherwise desperate situation, and another joint convention was held at the end of March, when it was found that the only way out was to permit any district which could do so to make a bargain for a return to work on the 1903 basis, which means a restoration of the 5.55 per cent taken off in 1904, giving 90 cents a ton for screened coal as the basis.

These soft-coal operatives have not been poorly paid, and their advances in the past few years have been many and great. The schedule is shown in the following:—

	Pick Mining.	Hours Worked.	Drivers, per day.	Inside Men, per day.
1896	45c.	9 and 9½	$1.40	$1.40
1897	51 and 56	9 and 9½	1.52½-$1.65	1.52½-$1.65
1898	65c.	8	$1.75	$1.75
1899	65c.	8	$1.75	$1.75
1900	80c.	8	$2.10	$2.10
1903	90c.	8	$2.56	$2.36
1904	85c.	8	$2.42	$2.23
1905	85c.	8	$2.42	$2.23
1906	90c.	8	$2.56	$2.36

Coming to the anthracite situation, the men there have been ordered out. This was done while negotiations were pending looking to an adjustment of the wage basis for another period, and after they had worked under the Anthracite Strike Commission award of 1903. The loss of work will cost the anthracite miners an aggregate of something like $370,000 a day in wages. This would be at the rate of over $2,218,000 for a week of six working days, and about $8,875,000 a month. These figures are based on the number of men employed and the average wages paid since the award of the Strike Commission has been in effect. The miners worked 231 days in 1904, receiving therefor $85,519,291.

The total wage cost of anthracite mining, according to the figures compiled by the State Bureau of Mines at Harrisburg, Pa., was more than double that paid employees in the bituminous mines and the daily and yearly individual pay of anthracite working men is greater than that of the bituminous miner in every case except that of the men outside.

Tabular Statement of Pay of Coal Miners in the United States.

	Anthracite		Bituminous.	
1904. Details.	Yearly.	Daily.	Yearly.	Daily.
Average	$626.77	$2.71	$431.02	$2.29
Men; miners	684.78	2.96	418.15	2.22
" miners' laborers	462.18	2.00	.....	...
" inside	780.58	3.38	492.15	2.62
" outside	541.62	2.34	475.36	2.53
Boys	241.31	1.04	165.99	.88

As to the destinations of the shipments of anthracite, showing the section of the country most affected, the following may be taken:—

	Tons.
Pennsylvania, New York and New Jersey	41,000,000
New England States	8,700,000
Southern States	2,100,000
Western States	7,070,000
Pacific Coast	5,000
Dominion of Canada	2,500,000
Foreign ports	35,000
Total	61,410,000

The division of the shipments of anthracite from the collieries by sizes during the past year was as below:—

Lump	2.62 per cent	1,609,885 tons.
Broken	6.90 " "	4,238,069 "
Egg	12.31 " "	7,562,414 "
Stove	19.16 " "	11,765,449 "
Chestnut	19.91 " "	12,249,398 "
Pea	13.71 " "	8,419,097 "
Buckwheat	14.62 " "	8,979,273 "
Smaller	10.73 " "	6,586,614 "
Total	100 " "	61,410,199 "

In addition to the small coals in the above statement was the amount produced at the washeries, amounting to 2,644,000 tons. If one puts all this into the list of coal in the East competitive with bituminous, there is a total of 27,000,000 tons.

The output of prepared sizes and steam sizes by regions in 1905 was:—

	Wyoming.	Lehigh.	Schuylkill.
Prepared	22,823,157	4,517,861	10,084,200
Small	13,034,741	3,331,344	7,618,899
Total	35,857,898	7,849,205	17,703,099
Prepared (per cent)	64.66	57.56	56.96
Small	35.34	42.44	43.04

The total production of marketable coal (Ruley's figures) in all the regions was 61,410,201 tons, of which 37,425,217 tons, or 60.94 per cent was prepared coal and 23,981,984 tons or 39.06 per cent small sizes.

The anthracite-miners' committee of the United Mine Workers has formulated a number of claims for advances for another season from April 1st, 1906, which would, very naturally, increase the price of coal to the consumer. Anthracite coal-mine operators offered to compromise with the miners and avert a strike. At first they demanded a reduction in wages, while the miners asked for an increase. Later they said that they would agree to abide by the terms imposed by the Anthracite Commission three years ago for another period of three years. These terms include a nine-hour day, a 10-per-cent increase in wages over that they had previously received, and a percentage on all increases in price. It is open to serious doubt whether the miners would have been able to exact such terms had the last contest been fought out to a finish. It is still more doubtful now if they can wrest further concessions from the operators. Even if by any freak of fortune they should win in a strike, their gains would be eaten up by their loss during the period of idleness.

It is not denied by the miner interests that the anthracite workers have enjoyed, during the last three years, a period of prosperity almost unprecedented. They have had the full benefit of the rise of coal prices, and it is only the public that has suffered. This was assured by the sliding-scale plan, which guaranteed increase of wages with the increase over $4.50 per ton price at tidewater, and held wages firm should the rate fall below that. All the reports from the anthracite fields, indeed, have indicated that the miners, individually and as a whole, are satisfied with their condition.

The anthracite operators say, in regard to the demands made by their employees, that they are excessive and without warrant, comprising as they do:—(1) An increase of 10 per cent to all miners engaged in cutting coal, or other men engaged on contract work. (2) The establishment of a minimum day wage for each class of labor; this minimum day wage, in many instances, is 100 per cent greater than the rates now being paid. (3) The establishment of an eight-hour day, instead of a nine-hour day, without any reduction in a day's pay.

By careful calculation from the payrolls of the operating companies, the effect of these three increases is to add an average of 21.64 per cent to the actual labor cost per ton of coal. This is equal, at the present labor cost of $1.55, to an increase of 33,68 cents per ton on all sizes of coal which are mined. Inasmuch as so large a proportion is small coal, which comes in competition with bituminous, therefore selling at a low figure, the cost of domestic sizes

is thus increased. This placing of the burden on the domestic sizes—a fact against which there is no appeal—brings it about that the labor cost of each ton of coal sold to the "domestic" consumer would be raised under the new demands by 51.8 cents a ton. The question is, then, whether the consumer will agree to pay a further increase in the cost of his domestic fuel.

The total tonnage of the country has grown at a rapid rate. The results are shown, in net tons, below:—

Year.	Anthracite.	Bituminous.
1880	28,649,000	71,067,000
1890	46,460,000	111,318,000
1900	57,379,000	209,700,000
1905	76,475,000	308,925,000

As stated earlier in this review of the situation, the permitting of any district in the organization of the United Mine Workers to make terms rather weakens that organization. At the same time it tends to a disruption of the Inter-State agreement plan and idea. Much has been said about the "tight contract" to which the miners have bound the Illinois operators during the last few years, and their position in relation to their competitors and to their markets has been a subject of much remark and not a little writing. The fact is—and it is and has been the dominating fact—the miners of that State are compactly organized; have a large fund available to conduct detail fights, and have been led by men of radical ideas, even for miners. It would seem, from the results of the last Indianapolis convention, that the Inter-State agreement as at present organized is a dead issue, and that Illinois and Indiana must get together, and that Ohio must link her fortunes with the Pittsburgh district, or, like the latter, go it alone.

Naturally, under the conditions that have existed since the first of the month, there has been an excited market for coal, and prices have for the time being advanced in some instances a dollar or more per ton over the former price. Producers of soft coal have naturally raised their prices to the basis of $4 for gas slack and ordinary steam grades, and $4.50 for specialities, f. o. b. New York harbor shipping ports. Consumers are clamoring for all the bituminous coal they can lay their hands on, as they realize that the situation will soon be taken advantage of by the speculative interests. All the leading anthracite operators and coal-carrying roads have agreed not to raise their prices on the accumulations of hard coal, which they have been storing for several months, until they have exhausted all that they can sell, and still have a moderate surplus for themselves. The official circular prices, in accordance with the

agreement of the operators, remain unchanged as follows:—Egg, stove, and chestnut, $5; broken, $4.75; pea, $3; No. 1 buckwheat, $2.50; No. 2 buckwheat, $1.85; rice, $1.40. At the same time, any coal that is available, as in yard, or due on contracts to the commission houses, had been increased fully a dollar a ton over these figures before the first week in April had passed.

The conditions have thus far been discussed that the reader not familiar with the situation may have a clear understanding. The national organization of mine workers in the United States has attempted to shut down every mine in the principal coal-producing States—not permitting any competition of one grade with another, in order to force the producers to give way and pay the scale demanded. In effect, one has the condition presented to the American people that its coal supply must be produced by union labor, that wages for producing it shall be whatever they may demand, that these demands will continue whenever in the opinion of the mine workers' union the occasion would seem to warrant such demands. It is a sample of the arrogance of the labor element and a defiance of the American idea that there should be a square deal for everyone. The power exerted by the leader of the United Mine Workers', who can call idle hundreds of thousands of men, is unequalled by that of any sovereign in the world, and it remains to be seen how long it will be before the nation will awaken to the conditions in the coal-mining industry.

EDITORIAL COMMENT

THE conditions at San Francisco are too overwhelming and the reports still too chaotic for more than elementary deduction. Two important facts seem certain:—first, that if fireproof construction had been general in San Francisco, the loss would have been but a fraction of what it is; and second, that the steel-skeleton building exceeded even the best hopes of its advocates in resistance to the earthquake. The type evolved out of the conditions of the newest civilization has proved itself best adapted to cope with the violence of primeval forces.

The steel framework and reinforced concrete offer trusty armor to the undaunted city, already rising to fight again. But in the years of emergency and stress that lie between the present ruin and the San Francisco of the future, what part are the labor unions going to take?

* * *

The announcement of the early retirement of Professor F. R. Hutton as active secretary of the American Society of Mechanical Engineers comes as a surprise to many of his friends in the Society, but this is coupled with a sense of satisfaction when it is learned that he will continue as Honorary Secretary and give as much of his time as is practicable to the furtherance of the work of the organization to which he has devoted twenty-three years of active service.

There are few men who can point to such a long period of devoted and successful work as can Professor Hutton in connection with the upbuilding of an organization which has grown from small beginnings to a position in which it is one of the dominating influences in the applied science of engineering in the United States; and it is with a feeling of unqualified praise that we express what we fully believe is the opinion of the whole profession in all parts of the land, when we state that without the work which Professor Hutton has so well done, the American Society of Mechanical Engineers would not have attained its present commanding position.

* * *

In connection with the present discussion of the compulsory introduction of the metric sytem into the workshop, a recent communication of Professor Gisbert Kapp to the London Times is of interest. After advocating the use of the C. G. S. system in connection with electrical computations, Professor Kapp says:

"I have never suggested that the metric system should be adopted in the English machine shop. What I did suggest was that the scientific part of the electrical engineer's work should be done on the basis of the C. G. S. system. Having finished his design, the engineer may then finish his working drawings in any system of units he pleases. The mental labor required to translate centimetres into inches is trifling, and I do not think anyone can reasonably object to figuring working drawings in inches, although the calculations of which these drawings are the result, may have been done in the C. G. S. system."

In other words, an engineer, brought up in the midst of the metric system, sees no good reason for any change in the workshop practice of the United States or Great Britain, although he himself advocates the employment of the metric system for electrical computations.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

TELEPHONE ENGINEERING.

THE RELATION OF THE ENGINEER TO THE SOLUTION OF THE TECHNICAL AND COMMERCIAL PROBLEMS OF TELEPHONE COMMUNICATION.

J. J. Carty—American Institute of Electrical Engineers.

WHEN the telephone was first introduced the technical problems connected with its installation naturally fell into hands of men expert rather in the department of telegraphic communication than with the wider questions of engineering, and it has only been within the past ten or fifteen years that a distinct department of applied science known as telephone engineering has become firmly established. The magnitude and importance of the work of the telephone engineer is even yet not fully appreciated by many, and hence the paper presented by Mr. J. J. Carty at a recent meeting of the American Institute of Electrical Engineers is especially worthy of notice and review.

After mentioning the incidents of the progress of the telephone engineer from what may be termed a switcl board man to his present broad field of work, Mr. Carty illustrates some of the questions which arise for solution by discussing a typical example in telephone engineering:

"Let us take the case of New York City, with the suburban territory tributary to it, and assume that it is the intention of the telephone company to install within that territory a telephone system which will work at a proper degree of efficiency, and, at the same time, yield to the investor a fair return upon his investment; and that it is necessary not only that this condition should exist during the first stages of the project, but that the undertaking should be so managed that this condition will be maintained indefinitely. With such a problem before the telephone management, what part of it should the management require the telephone engineer to work out? I shall answer this question by describing in general terms, and sometimes for the purpose of illustration, in considerable detail, which should be the work of the telephone engineer in such a case.

"The first question which the engineer must decide is, what is the period for which such construction as may be required should be planned? This is a question of far-reaching importance, and requires for its answer that a vast amount of data should be collected, and that careful and long-continued study and investigation should be given to a large number of factors, involving, among other things, first cost and character of construction of the diverse portions of a plant of such complicated nature, annual charges, such as maintenance, depreciation and interest, and local conditions bearing upon the possibility of the renewal or extension at some future time of all of the elements of the plant.

"In addition to this, due regard must be paid to possible changes in the art, and also the fact that, owing to the exigencies of the business, many cases arise where it is necessary to carry out at the beginning, especially in underground work, all of the construction which may ever be needed.

"At the outset the question of the period for which to plan depends upon the expectations of growth. With a given ex-

pectation of growth, the engineer, by taking into account all of the factors of the case and balancing the annual charges resulting from the initial investment against the cost of reconstruction and rearrangement of the plant at some future time, arrives at the economical period for which to plan.

"In this work the predictions as to growth of the first importance, and inasmuch as accurate predictions of this kind are attended with the greatest difficulty, it is essential that not only the judgment of the engineer, but that of the business management, and all others who might be able to advise in connection with the matter, should be obtained.

"At this stage of the work it is of the utmost importance that the bearing of these estimates of growth upon the future of the plant should be thoroughly understood by the business management, whose functions, in the nature of the case, exercise such a profound effect upon the extent and character of such growth. It is the duty of the engineer to make this point clear, and to obtain from the business management serious and responsible estimates of future growth.

"The number of lines which may be expected having been agreed upon, the question of for how long a period ahead we should plan is determined by a number of circumstances. For such conditions as obtain at New York, the period for much of the construction has been found to be from seventeen to twenty years. This figure is arrived at by taking into account a large number of factors, such as life of the central switchboard—which is placed at about fifteen years, the relative costs of placing in the subways a large number of ducts initially as compared with adding new ducts after a period of about twenty years, the uncertainty regarding the changes in the state of the art, and the difficulty of foretelling with sufficient detail conditions which are expected to obtain during a period so far ahead as twenty years."

Mr. Carty then proceeds to discuss the manner in which the number and distribution of the lines are determined, including a study of the map, with location and boundaries of districts, situations of exchanges, offices, and switchboards. In all this layout of a vast scheme, including estimates for future demands in connection with economical provision for immediate business, there is ample scope for administrative and technical ability of the highest order. When to this are added the problems involved in the acquirement of real estate, the provision for suburban and long-distance connections, and the control of routes, something will be realized of the broad nature of engineering work, before any constructive problems have been attacked at all.

The whole question of the work of the telephone engineer bears testimony to the extent to which engineering has become interwoven with commercial questions. The physical problems belong to the various branches of applied science falling within the work of the civil, mechanical, and electrical engineer, but to these must be added a grasp of commercial and financial matters. Thus the adoption of the flat-rate or the toll-rate method of charging for service is intimately connected with the operations of the telephone engineer.

With the flat-rate method there was no definite relation between the service and the charge, and with the continually increasing service it became impossible to arrange for any determinate growth or distribution. This alone invited discouragement of the development of extension stations, internal exchanges, desk stands, and other auxiliaries tending to make the use of the telephone easy and, therefore, more frequent. The engineer, in endeavoring to plan his work in connection with the flat-rate plan, met with difficulties on every hand. The small users could not afford the necessarily high charge for the flat-rate, so that only those having a large number of calls could install a telephone, the result being a system largely composed of overloaded lines. A second line usually meant doubling the cost, and hence gave no aid in meeting the question.

As soon as the message rate was introduced, it became possible to furnish the service to many to whom it had formerly been impossible, while at the same time it became the interest of the company to encourage the use of the telephone in every manner. Local switchboards and separate

instruments were installed at very moderate charges, because their presence caused a natural development in the use of the line, with a proportionally increased revenue, and the whole situation became changed.

"Considering these two examples of the method of charging which shall be followed upon toll lines, and the method of charging which shall be adopted upon subscribers' lines, it will be seen that they in a most extraordinary manner affect the work of the telephone engineer. So profoundly do such considerations affect the proper engineering of the telephone plant that it must be said that good telephone engineering can not exist side by side with a bad system of rates, or with improper business methods and organizations. Nothing more forcible than these examples needs to be mentioned in order to show the intimate relations between telephone engineering and business management.

"From time to time, engineering methods involving new principles are brought forth. These, when found to affect the methods of the business office, should be submitted to the business management with a full and clear statement of their bearings upon the commercial work of the company. On the other hand there are, from time to time, business proposals and commercial methods which are under consideration by the business management of telephone companies, and which, apparently, are only remotely, or not at all, related to engineering. In view of the many unexpected and important reactions which these proposals may have upon the engineering of the telephone plant, it becomes of the first importance that they should be scrutinized carefully from an engineering point of view, unless it is conclusively apparent that they will be without effect upon the engineers' plans."

Mr. Carty gives some attention to the question of automatic systems as compared with the manual system, and shows that an extensive comparison of systems in regular working operation shows that the actual cost of the automatic method is greater than that of the manual switchboard, while the service is inferior.

The relations of the telephone engineer have thus reached a position vastly more important than could have been imagined at the beginning. He must broadly determine all of the important features of the plant of the company, and he must in detail decide what shall be the nature of the construction and the method of operation of every single item which constitutes the physical property of the telephone company.

"Viewed from this standpoint, 'it will be seen that while the function of the engineer with relation to the plant is of the utmost importance, nevertheless the work of the traffic, maintenance, construction and other departments has such an important bearing upon the whole system that the successful engineering of a telephone system must be regarded not only as the work of the engineer himself, but as the work of all the other departments concerned. Not only this, but what is still more important, the successful engineering of a telephone plant depends upon proper business management. Without an intelligent, progressive, and broad-gauged business management, there can not be good telephone engineering."

THE TEHUANTEPEC RAILROAD.

COMPETITIVE INFLUENCES OF RATES ON THE TEHUANTEPEC AND PANAMA RAILROADS AND THEIR RELATION TO THE PANAMA CANAL.

John F. Wallace—Railway Age.

IN the course of an address delivered before the Illinois Association, and published in the *Railway Age*, Mr. John F. Wallace gives some important and interesting indications as to the relation of the recently completed Tehuantepec railroad upon isthmian traffic. This railroad, constructed in the interests of British capitalists, is an extremely well built line, provided with the best modern facilities to handle a large amount of traffic at a minimum rate. It is expected that it will be possible to transport merchandise from ocean to ocean at a cost of not more than

$2 a ton, from ship hold to ship hold, the time from ship to ship not exceeding two days.

Taking the facilities of this route into consideration, and assuming as a fair ocean rate $1 per thousand miles, Mr. Wallace proceeds to give some computations of the cost of merchandise transport between various ports, as follows:

From New York to Australia, say the port of Sydney, the saving of distance by way of the Tehuantepec Railroad would be 5,700 miles, and any railroad rate across the Isthmus of Tehuantepec, less than $5.70 per ton, should take this business from the Suez route. In addition it would save the time it requires an ordinary cargo vessel to steam 5,700 miles, minus the time required to transfer the freight across the isthmus by rail. This would make an actual saving of time of at least 15 days, even allowing the maximum of four days for the isthmian transit.

From New York to India and China points, this route would not be so material, as the line of least resistance from a traffic standpoint would never be over the transcontinental lines through San Francisco, Seattle or other Pacific ports.

From Liverpool to points in the far East where the distance is the same, the Tehuantepec Railroad could charge the Suez tolls, which are approximately $2 per ton, and compete for the business with a fair profit.

Turning to the ports, however, in the United States, the advantages given by this route are also remarkable. From New Orleans to Hong Kong, the saving would yield the Tehuantepec Railroad $4.80 a ton on the basis of equivalent charges by the Suez route, in addition to saving from 12 to 14 days in time.

From New Orleans to Yokohama the saving over the Suez route would be 8,400 miles, which would enable the Tehuantepec Railroad to charge $8.40 per ton for the transit of freight on its railway, on an equivalent basis with Suez, and save approximately 24 days in time.

From New Orleans to Australia, the port of Sydney, the figures would be practically the same. As there is little question of the ability of this railroad to handle freight from ship to ship for $2 a ton or less, its ability to build up an enormous business to the far East in competition with the Suez route is plainly manifest.

Let us now compare the Tehuantepec route with that of the Panama Canal, on the same assumption that $1 per ton will carry ocean freights 1,000 miles and that $1 per ton will be the minimum rate charged for transit through the canal.

From Liverpool to Hong Kong, the saving in distance via Tehuantepec will be 1,200 miles, and allowing two days for the transit of the freight across the Isthmus of Tehuantepec, the saving of time will be approximately two days. The saving in distance will be equivalent to $1.20, which, added to the minimum charge of $1 through the Panama Canal, would give $2.20 as a maximum charge to the Tehuantepec Railroad.

From Liverpool to Yokohama the saving, as against the Panama route, will be 1,100 miles. From New York to Australia, port of Sydney, the saving will be 761 miles, which, on the same basis as just stated, would yield the Tehuantepec Railroad a maximum charge of $1.76 a ton, or approximately 1 cent per ton per mile, some 40 per cent higher than the average rate on the trunk lines in the United States.

From New York to San Francisco, the saving will be approximately 1,200 miles, which would yield $2.20 as a maximum rate to the Tehuantepec Railroad.

From New Orleans to Hong Kong, a common point for Northern China, the saving of the Tehuantepec line over Panama is approximately 2,000 miles, which would permit the Tehuantepec Railroad to charge a maximum of $3 per ton on an equivalent basis, and save in time approximately five days.

From New Orleans to Australia, port of Sydney, the saving would be approximately 1,400 miles, allowing the Tehuantepec Railroad a maximum charge of $2.40.

From New Orleans to Honolulu the saving would approximately be 2,000 miles, permitting the Tehuantepec Railroad to charge a maximum rate of $3 per ton.

From New Orleans to San Francisco the saving in distance via the Tehuantepec route would be 1,800 miles, permitting the Tehuantepec Railroad to charge a maximum of $2.80 a ton, with corresponding saving of several days in time.

It must be remembered that these figures represent rates which are about available at the present time, or at least upon the opening of the Tehuantepec route to traffic. Trade is more or less conservative, and clings to established routes unless important advantages can be shown in favor of a change, and during the years which must elapse before the Panama canal can be opened to traffic the Tehuantepec route will have established itself as on definite lines with which the canal will have to compete.

Mr. Wallace shows that the proper way to meet this possibility is to create a competition immediately by means of the Panama railroad. By the immediate provision at Panama of the proper facilities and equipment for the maximum efficiency of the Panama Railroad, and the putting in of a flat rate of not more than $2 a ton, and possibly as low as $1.50, the diversion of traffic from that route can be prevented, while the traffic tributary to it can be encouraged and expanded, and the business thus built up will be ready for the canal when completed.

A rate as low as $1.50 a ton—which will give an average of 2 cents per ton per mile for transit over the isthmus, and allow 50 cents per ton for the handling of freight from ship to car and from car to ship—would be ample after complete facilities for handling the business had been provided and the business had increased to a sufficient amount to justify it—say to 1,000,000 tons per annum.

So far as the mere question of rate is concerned, with the only disadvantage of breaking bulk, this rate would immediately enable America to compete with the Suez Canal on all traffic from the United States ports to the far East, and from the ports of Europe and Australia, Japan, China, and all points east of Singapore, and, so far as trade with the west coast of South America is concerned, this would give the United States, particularly the Mississippi Valley, a decided advantage over all the ports of Europe, and would enable the larger part of the advantages of the Panama Canal to be anticipated. It would give American merchants and manufacturers such a foothold in this trade, provided it is properly catered to and developed, as would enable it to be held, at least in part.

The failure of the United States to improve and utilize the Panama Railroad to its full capacity, and do it at once, may seriously affect the value of the government Panama investment, which has already reached 70 millions of dollars, and may reach 300 millions.

The great direct benefit of a flat rate of $2 a ton or less across the Isthmus of Panama by rail will at once put the United States in a position where, for a comparatively small investment not exceeding 2 per cent of the total cost of the canal—which investment should be made in any event, in order to assist in its constructiona large percentage of the ultimate advantage to be derived from the canal commercially, will be secured. The greater part of this benefit will lie in the reduction of rates, which will result to the benefit of the agricultural and commercial interests of the countries in Central and South America bordering on the Pacific below the Mexican line.

While the proportion of rates which have accrued to the Panama Railroad on business from New York to San Francisco has been low and reasonable, its charges on the traffic passing over the isthmus to and from the countries bordering on the Pacific Coast in Central and South America have been exorbitantly high, and have been kept by the countries affected thereby. It will without causing the traffic to be diverted around Cape Horn. The rate which accrued to the Panama Railroad on coffee from Costa Rica has been as high as $6 a ton for the distance across the isthmus, say 50 miles. A lowering of the rate to $2 a ton or less will stimulate all forms of agricultural and commercial enterprises in the countries affected thereby. It will largely increase the population and the consuming capacity of these countries; and if this trade is properly fostered and catered to by American manufacturers and merchants it should yield large benefits and cement the politial, commercial, andc frDbe cement the political, commercial and personal friendships between the United States and the nations of Central and South America.

In view of the above façts it appears to be high time for the United States Government to realize the situation and use the Panama Railroad to meet this competition.

THE POWERING OF MACHINE TOOLS.

EXPERIMENTAL DETERMINATIONS OF THE POWER REQUIRED TO DRIVE STANDARD MACHINE TOOLS WITH REFERENCE TO ELECTRIC DRIVING.

G. M. Campbell—Engineers Society of Western Pennsylvania.

BEFORE the introduction of electric driving there existed some very erroneous ideas as to the power required by various machine tools in performing such ordinary shop operations as turning, boring, planing, drilling, and the like. Designers of tools had learned by experience about how they should be belted, and it was well known that anywhere from 30 to 50 per cent of the engine power was consumed in getting the power to the work, but the actual distribution of the power among the various tools was largely a matter of guesswork. Some tools and machines were known to absorb what seemed like disproportionately large amounts of power: and wood working machines, such as planers, surfacers, and similar machines, as well as fan blowers, were known to be great consumers of power.

When the electric motor came into use it brought with it, among its many advantages, the opportunity of determining accurately and readily the actual amount of power delivered at any moment, the result being a large access of information concerning the power required in the different workshop operations. The information thus acquired has again reacted upon the motors themselves, being used in the proportioning of the motors, as well as in what may be called the powering of the machine tools, or the selection of the size and capacity of the motors to be used in the various cases. In a paper recently presented before the Engineers' Society of Western Pennsylvania by Mr. G. M. Campbell some of the considerations which govern the powering of machine tools designed for direct electric driving are given, including the results of many practical tests, tabulated and compared with the computed amount of power indicated by empirical formulas.

Apart from the supply of the maximum amount of power required, one of the most important considerations in connection with electric driving appears in the necessity for a satisfactory speed control.

In machine tool work speed variation is essential, and in a machine driven by an individual motor part of the speed variation must be obtained in the motor itself if efficient speed control is required. The range of speed required in some machines may be quite limited, on account of the particular class of work for which the machine is used, and in such a case the full range of speed could be supplied by the motor. On the other hand, the speed variation required may be so great that it is impossible to supply it all by the motor.

Just what range of speed is required in the motor cannot be definitely stated for all conditions. If a total speed range of six to one is required in a machine, it might be advisable under certain conditions to obtain this total range in the motor, but as a general rule the writer believes it would be advisable to use at least two runs of gears when the speed change required exceeds four to one, and that a somewhat better and more efficient design can be obtained when the speed change required in the motor is limited to about three to one.

Other conditions being the same, the power taken by a machine, after allowance is made for friction losses, will vary approximately as the speed and cut, and therefore as the weight of metal removed, consequently in fitting motors to tools alallowance must be made for high speeds and maximum cuts, bearing in mind the coming universal use of high-speed tool-steels and the increase in rigidity of machines.

In general, the power required to drive a machine can be computed by multiplying the weight of metal removed per minute, in pounds, by a coefficient depending upon the kind and grade of the material. This coefficient ranges from 1.4 for cast iron, to 3.6 for hard steel, with intermediate values for materials of hardness between these limits. Of course, the condition of the cutting tool as much influence upon the power consumption, and a dull tool, or one of improper form, may cause a much greater

amount of power to be uselessly consumed.

The friction losses in machine tools which run continually in the same direction, as lathes, drill presses, etc., are not very great, and, so far as can be ascertained, these losses do not bear any direct proportion either to motor speed or to spindle speed.

There is a class of machines where the size of motor required depends very largely on the machine itself, almost independent of the size of cut it has to take, this is the reciprocating tool, as the shaper and planer, and to a somewhat less extent the intermittent working machines, such as punches and shears. In planers where shifting of belts is relied on to reverse the motion, the statement is fairly accurate; in tools where the reversal takes place by magnetic clutches or motor reversal it is not so much so, as the power taken by the motor can be better regulated. In planer drives where motor runs continuously in one direction, it is of relatively little importance how much the platen or the load on it weighs, but the size and weight of the revolving pulleys which have to reverse it is of very great importance. These pulleys should be as small and light at the rim as capacity will allow; and on one of the revolving shafts, preferably on the motor shaft, there should be a flywheel of large diameter and heavy rim so as to aid the motor at moment of reversal.

With intermittent machines, such as shears, punches, and the like, in which the maximum effort occurs suddenly, it is very desirable that a properly proportioned flywheel be used, thus averaging the resistance, and rendering it unnecessary to provide a motor as large as the maximum load would indicate. Thus, in the case of a punch for which the power diagrams are given by Mr. Campbell, the maximum horse power rose to twenty-one, while a similar machine with a heavy geared flywheel, required but 7.9 horse power on the same test.

Mr. Campbell gives some interesting data and results of tests upon tools in the shops of the Pittsburgh and Lake Erie Railroad Company at McKee's Rocks. Thus, a 90-inch driving-wheel lathe consumed from 9 to 15 horse power, according to the depth of cut and the hardness of the material. The horse power required to remove one pound of metal ranged from 3.87 to 1.50, this showing the variation in the material under operation.

A large number of special conditions may enter into the determination of the size of the motor required for any particular tool, the class of work it is to be restricted to, the grade of material, whether cuts, if heavy, will be of short duration, etc., so that it is rather difficult to make a statement that will fit all cases, but the writer would suggest the following for determining size of motor for average conditions—assume a cutting speed of fifty to seventy feet a minute for soft steels, estimate the maximum size of cut that will likely be required for any time longer than thirty minutes, transfer this into pounds of metal removed per minute and multiply by 2.7, then select a motor which will develop this power throughout the range of speed desired.

MOISTURE IN SUPERHEATED STEAM.

EXPERIMENTAL STUDIES TO DETERMINE THE POSSIBILITY OF THE PRESENCE OF WATER IN STEAM ABOVE SATURATION TEMPERATURE.

By Fritz L. Richter---Verein Deutscher Ingenieure.

IN considering the advantages obtained by the use of superheating of steam in engines several points have to be considered. The primary question, doubtless, is the possibility of minimizing the losses due to cylinder condensation, by keeping the working fluid at a temperature farther above the point of liquefaction than would be the case with saturated steam. It has generally been assumed, however, that with even a moderate degree of superheat, the steam must necessarily be dry, and superheating has therefore been principally regarded as an effective means of preventing the entrance of entrained moisture into the engine cylinder. Of late, however, the accuracy of this latter matter has been questioned, and hence the careful experi-

ments recently conducted by Herr Fritz L. Richter, at the mechanical laboratory of the Charlottenburg technical high school, and published in a recent issue of the *Zeitschrift des Vereines Deutscher Ingenieure*, are to be welcomed as valuable contributions to a more accurate knowledge of the actual facts in the case .

Experience with superheated steam has demonstrated that there are various things neccessary to obtain the full benifit besides providing a means for superheating and an engine in which high temperature steam can be used without injury. Hot steam is practically hot gas, in so far as it parts rapidly with its heat to surrounding objects, and the researches of Dr. Berner have shown how important it is that the piping should be most carefully jacketed and protected against radiation losses. In like manner it must be noted that the presence of a separator, generally advisable with saturated steam, may prove a source of loss with superheated steam, permittng the temperature to drop, and becoming a place for the formation of moisture.

Moisture in steam mains may appear in two forms: it may exist as a thin film, in contact with the walls of the pipe, owing to the fact that radiation causes the pipe itself to be cooler than the core of the steam flowing through it; or, it may be in the form of drops, swept from the walls where it was formed, and carried along by the current of flowing steam. These two cases, as stated by Herr Richter, do not include the possibility of entrained water being carried bodily out of the boiler and into the pipe by mechanical action. Herr Richter is rather of opinion that in many forms of separators the sudden change of direction relied upon to remove the entrained water from the steam may do more harm than good, by causing the steam to pick up the water from the metallic surfaces to which it would otherwise adhere, and create such an intimate mixture as to render its subsequent separation a very difficult matter. However this may be, it is evident that experimental investigation is the only way in which definite information can be applied to the definite solution of the question, and for this reason the Charlottenburg researches are of importance.

The apparatus employed by Herr Richter consisted of a drum about 30 inches in diameter and five feet long, arranged so that the steam could be admitted in the middle of one head, the jet impinging upon a fixed cup similar in form to the bucket of a Pelton water wheel, the steam striking the cup on one side of the concave surface in such a manner as to cause the current to be entirely reversed and its velocity checked. Observation windows were arranged in opposite sides of the drum, and the interior illuminated by incandescent electric lamps in such a manner as to enable the action of the steam jet to be studied, and the presence of water and the formation of drops to be examined critically. In this respect the drum formed something like an enlarged arrangement of the "revealer" designed by the late Mr. Bryan Donkin for the study of condensation phenomena in the cylinders of steam engines. The drum was provided with drainage connections, mercurial gauges, thermometers, etc., so that the data accompanying any observation could be noted and recorded.

When saturated steam is delivered into such a drum the absorption of its energy by the checking of its velocity causes its temperature to rise, producing a corresponding degree of superheating, recorded by the thermometers. As observed through the windows, the cold walls of the interior of the drum were almost immediately covered with moisture, which gathered into drops and collected at the bottom. As the temperature increased this water was gradually evaporated, while the walls became dry. The nozzle through which the steam flowed gave practically an adiabatic expansion of the steam before it reached the reversing bucket, and it was possible to see clearly the formation of drops of water in the expanding steam before the rise in temperature took place, and also to determine the absence of entrained water at the beginning of the expansion. The experiments were made principally upon steam of low pressure, the superheat ranging from 24 to 44 degrees C. above the saturation temperature.

For the details of the experiments and the tabulated results the reader must be referred to the original paper, but the con-

clusions may be given here. It was definitely determined that for each set of steam conditions, each diameter of pipe, and every kind of pipe, there exists a degree of superheat above which no water can exist in the liquid state, either in the mass of the steam, or as a film upon the metallic surfaces. If steam is to be conducted through pipes or mains without the formation of water it is therefore evident that such an excess in temperature over that of saturation must be maintained, otherwise condensation will occur, both in the mains and in any separating device which may be employed. The question of the drop in temperature during transmission, due to distance, velocity of flow, etc., must be taken into account, in order that the critical minimum degree of superheat below which liquefaction may occur shall not be passed, is an important one, and these points should be fully considered in arranging a power system for superheated steam, this preliminary degree of superheat being included in the total, but not counted on as available in connection with the conversion of energy in the cylinder.

Herr Richter gives a number of tables arranged from the experiments of Dr. Berner upon the losses in the transmission of superheated steam through mains, and from these it is possible to deduce formulas enabling the degree of superheat to maintain dry steam to be determined for practical installations. Above all these researches show the desirability of arranging close proximity for boiler and engine in plants using superheating, removing as much of the transmission loss as possible by reducing the distance, and this point may go far toward accounting for the high efficiency which has been attained with superheating in semi-portable equipments in which the engine is attached to the boiler and the steam passes directly to the cylinder without any exposed main.

WORKSHOP ILLUMINATION.

PRACTICAL CONSIDERATIONS GOVERNING THE EFFICIENT LIGHTING OF WORKSHOPS BY ARTIFICIAL APPLIANCES.

A. E. A. Edwards--Coventry Engineering Society.

ARTIFICIAL lighting is at best but an imperfect substitute for daylight in the machine shop, but since shops must be artificially lighted during the winter season, or when night work is required, it is most essential that the best lighting methods be employed, and the loss of illumination reduced to a minimum. It must be remembered that the efficiency of workmen is always lower with artificial lighting than with daylight, while the rate of wages is usually higher, so that it is the worst kind of economy to attempt to save money at the expense of light.

In a paper presented before the Coventry Engineering Society by Mr. A. E. A. Edwards, this subject of workshop illumination was discussed in a very practical manner, and some abstract of his remarks will be found of value and interest.

In the first place the importance of providing good reflecting surfaces to the walls and ceiling is emphasised. It is computed that with a room of which the interior is painted white, a 20 candle-power lamp will give the same illumination as a 100 candle-power lamp in a room with black surfaces. White paint, or even whitewash, is not expensive, but, so far as adding to the returns from investments in lighting are concerned, they are most efficient. In the same line of improvement comes the obvious one of painting machinery a light color, a light gray, or lead color giving a much better distribution of the available light than if any dark color is employed.

It must not be assumed that the color of the walls or of the machines is in tself enough to insure the proper lighting of any particular detail, but it will add greatly to the general illumination of the room. A brilliant lighting at any definite point, as upon a vise or lathe, can only be obtained by having a light near that point; but in such cases the use of a suitable reflector of paper or other material will enable a resultant illumination of easily 50 per cent more than would otherwise be obtained. Experiment has shown that a mirror reflects 95 per cent of the light

which falls upon it, while white paper reflects 80 per cent, so that a very efficient reflector of any desired shape may readily be made of a sheet of clean white paper or cardboard.

In this connection Mr. Edwards makes some valuable observations about the obstruction to light caused by shades of various materials. Thus an ordinarily plain glass window will obstruct from 7 to 10 per cent of the light falling upon it; ribbed glass will obstruct 15 to 30 per cent, while the loss with opaline glass is 15 to 40 per cent, and with ground glass, 30 to 60 per cent. It must be remembered, however, that losses fully as great as these may easily occur with clear glass if the windows are allowed to become dirty, and the same is true of globes and shades for artificial lights. Although at least 15 per cent of the light is absorbed by an opal globe, it is better to use the globe than the naked light, because the light is diffused from the whole surface of the globe, and sharp shadows are thus avoided.

With regard to the height of lights, it must be remembered that one candle at 1 ft. distance will illuminate a surface as well as four candles at 2 ft., or 16 candles at 4 ft. Therefore lamps should not be placed higher than necessary, or the illuminating effect is lost in a great measure. If there is no other controlling circumstance, except to get a good general illumination on the floor or tables of a room, the distance between the lights should equal their height above the surface to be illuminated.

Now as to gas burners — simple little things at 1d. each, and yet much thought and care has been expended on their design and construction. The light we get from a burner does not depend altogether on the amount of gas that is passed through it. For instance, if we take two gas jets burning in an ordinary manner, and place them side by side, so that the two flames intermingle, the candle-power of the resultant flame is much greater than the candle-power of the two flames burning separately. In an ordinary union-jet burner there are two holes fairly close together. After use these holes alter in size and shape, and the lighting power of the jet rapidly deteriorates; these burners usually give 1¼ to 1½ candle-power per cubic foot of gas used per hour, while a good steatite burner gives 2½ candle-power per cubic foot. The inference to be drawn is that as soon as the shape of the gas flame has become altered you may know that you are using that burner at a low efficiency, and it will pay you to throw the burner away and to put on another. Always start the winter with new burners all round, and if an old No. 5 burner gives light enough, put on a new No. 4 instead. This will give as good a light, and save about 1½ ft. of gas per hour.

The pressure of gas will affect the consumption and candle-power per burner to a very great extent. Governor burners, which can be bought for about 6d. each, are often more serviceable than the expensive apparatus fixed in the main supply pipe, which at best will only serve for one or two floors, as the pressure of gas increases 1-10 in. for each 10 ft. rise.

Incandescent gas lighting is the most economical system of lighting we have at present, where there is very little vibration and the lights are fixed.

Incandescent gas burners rapidly accumulate dust, and should be thoroughly cleaned every 200 or 300 lighting hours, or oftener in very dusty places. Such lights, when properly installed and well cared for are very satisfactory, but they should not be used on hinged brackets, or anywhere where there is continual vibration. Mr. Edwards gives the results of tests of incandescent mantle burners with Dowson producer gas, showing an illumination of 8 to 10 candle-power with a consumption of 4.5 to 4.8 cubic feet of gas. With a sufficient pressure and volume of gas there is no good reason why producer gas should not be used to great advantage in this manner, without any carburetting or other special preparation.

Incandescent electric lamps are very badly used by many men who have not studied the relation between the voltage, the efficiency, and the life of the lamp. A high efficiency lamp means that the energy consumed, when the lamp is new, is from 2½ watts to 3½ watts per candle-power, instead of 3.75 to 4 watts per candle-power, the ordinary consumption. High efficiency is attained by making the carbon filament hotter than usual. This causes

particles of carbon to fly off the filament on to the interior of the globe, and the lamps become blackened, and the candle-power is greatly decreased. The economical life of the lamp is, therefore, very much reduced. By economical life of a lamp is meant the hours a lamp will run before its candle-power is reduced 25 per cent.

The same thing occurs if the voltage is increased beyond that for which the lamp is constructed.

After the first few hours of over pressure the candle-power of the lamp rapidly diminishes, although the same quantity of current is used, and the result is that the workman is short of light, or else could do with a lower candle-power lamp to begin with, if it would maintain its efficiency for a longer period.

One object in specially mentioning this point about lamps is to give a warning against buying and using these so-called very high efficiency lamps.

Some electrical supply companies supply current at from 8 to 10 per cent over the normal pressure, and the result is that the lamps fed from their mains must either be replaced after about 200 hours' lighting, or they become so black as to be very seriously inefficient. The net result to the consumer is that he has 10 per cent more current forced through his lamps than he wishes to have, and for which he has to pay, and the candle-power of his lamps is no more than it would be with normal pressure, except for the first few hours the lamps are in use. The lamp renewals through breakage are also very excessive.

In the case of gas burners, as with incandescent electric lamps, it does not pay to run them until they break. The average life of a good lamp will be 1,000 hours, if they are not run over pressure, and at the end of that time it will certainly pay to break the lamp and replace it.

Arc lighting is one of the cheapest forms of artificial light for use in large buildings where a general light is required.

Arc lamps, like all other sources of light, should be so placed that the eye does not catch sight of the lamp while the workman is engaged in his occupation, although, on the other hand, they must not be "skied," for reasons I have given before.. The advantage usually claimed for the enclosed or double globe arc lamps over those of the ordinary type is that they require carboning only about once in 200 hours, although, on the other hand, the globes and rods should be cleaned about every 50 hours. The loss in lighting power through having a double globe is about twenty per cent more than with the single globe. The principal advantages of these lamps are that they can be run separately on a 100 or 110 volt circuit, whereas the ordinary arc lamps are obliged to be fixed two in series on a 100 volt circuit; and also that the insurance companies, in certain classes of risks, will not increase their rate for enclosed lamps, as they would do for ordinary arc lamps.

Inverted arc lamps are admirable where a soft, shadowless, pure white light is necessary, and are specially valuable if the ceilings are low; but with this style of lamp a white ceiling, or blinds over the lights, are quite necessary.

MODERN LOCOMOTIVE PRACTICE.

THE ACTUAL EFFICIENCY OF THE MODERN LOCOMOTIVE AND THE DEVELOPMENT OF THE LARGE LOCOMOTIVE.

W. P. Evans, G. M. Basford—Pacific Coast Club.

AT a recent meeting of the Pacific Coast Railway Club there was presented two papers of much importance relating to an interesting department of railway engineering; namely, to the modern locomotive and its efficiency.

The paper by Mr. W. P. Evans treated of the actual efficiency of a modern locomotive as represented by work actually performed, and hence it comes as a valuable pendant to the work of the testing plant of the Pennsylvania Railroad Company, the report of which was reviewed in these pages last month. A comparison of the economic performance of the modern large locomotive with the best machines of twenty years previous enables the works of the St. Louis testing plant to be compared

itself with the most severe of all tests, the everyday work and demands of actual railway service.

Mr. Basford devotes his paper almost entirely to the increase in weight and dimensions of the steam locomotive, and forms an excellent supplement to the paper of Mr. Muhlfeld upon large locomotives, and that of Mr. Churchward, upon large locomotive boilers, lately reviewed in these columns. It is most interesting to note that even in the midst of active work and discussion as to the possible replacement of the steam locomotive by some form of electric traction there has appeared a renewed interest in the performance of the steam machine, including both its efficiency and its capacity.

Mr. Evans shows that while little or no improvement in the steam consumption of the single expansion engine has been made over the locomtives of twenty years ago, the use of compounding has resulted in an economy, with freight engines, of about 17 per cent. Superheating, however, has proved even more effective than compounding in the reduction of the water rate, tests upon the coal consumption per 1,000 ton miles on the Canadian Pacific Railroad showing gains of 22 to 26 per cent, due to superheating. The actual first cost of locomotives has naturally increased with the increase in dimensions, but the cost per pound has fallen, on an average, from $0.087 per pound in 1885 to $0.082 per pound in 1905.

Mr. Evans treats the important subject of depreciation in an interesting manner, and in this respect his paper may be used to advantage in considering other kinds of machinery besides locomotives.

"As soon as the engine goes into service, its value takes a sudden drop due to the fact that it then becomes a second-hand machine. After this its depreciation is gradual until the cost of repairs and maintenance equals the service which can be obtained for it. Under average conditions prevailing in this country this occurs after a service of about twenty years when the curve of depreciation runs parallel to the base line.

It may be discussed systematically by dividing it into several principal headings.

Considering the original cost of the locomotive and its present value, to the cost charged by the builder should be added the freight charge for delivery and the cost of breaking in the locomotive. The value of locomotives which have been in service a number of years, but which are in good working order, may be obtained approximately by obtaining the net weight of the locomotive proper, without tender, and without water in the boiler, and multiplying this weight by seven for the value in cents.

"Depreciation must have some relation to the estimated life, but it is not necessarily as constant as is often assumed. The common rule is to divide the original cost by the estimated life in years to find the yearly depreciation. A more rational method is based on the fact that after certain periods of service locomotives depreciate more rapidly. When this is taken account of it is suggested that for the first five years the full second-hand value of the locomotive may be taken; for the second five years 85 per cent of this second-hand value; for the third five years 70 per cent; and after 15 years 50 per cent of the second-hand value; after 20 years 25 per cent of the first cost."

Another method suggested is to treat the value of the locomotive as an amount of capital to be redeemed by an annuity in a given number of years, and the annual payments determined from the actuarial tables on this assumption will then be the yearly depreciation to be deducted from the value of the engine.

As a matter of fact the depreciation of a locomotive depends more upon the service and use of the locomotive than upon the machine itself. The older engines were used more carefully and rendered less service than now, so that the increased depreciation charges really represent a part of the price paid for the increased capacity.

The real thing in which the railroad man is interested is the hauling capacity and the cost per ton mile and train mile. The increase in tractive capacity is given in tabulated form by Mr. Evans the average results of which are here given in condensed shape:

"The tractive effort of passenger engines has increased from 15,250 to 23,740, or 55.6 per cent; of freight engines from 25,720 to 46,600, or 81.2 per cent. These figures show an enormous increase in size of locomotives in use to-day over those employed twenty years ago. During this time, however, but

few railroads have seen any material improvement in the roundhouse facilities or shop equipment, and it is a grand tribute to the mechanical officers of railroads that repairs have been kept as low as they have.

"The table of actual train loads shows what has been done with the power available on the roads, part of it being light power built some time ago, and part the modern heavy power. The train loads have actually increased from 229 to 385 tons, or 68 per cent.

"With an increase of tractive effort of 55.6 and 81.2 per cent for passenger and freight engines in ten years, the train loads actually hauled have increased 68 per cent. These figures agree surprisingly well, which is a coincidence, because there are a great many considerations other than engine power which go to make up the average tonnage of trains hauled for a year."

The cost per ton mile depends to a large extent upon the train load. From 1895 to 1900 the increase in train loads brought the ton mile cost down from about 70 cent to 0.47 cent, while little or no reduction has been effected since. The lowest cost goes with the heaviest train, which itself accounts for the great increase in the weight of trains. During the past ten years the average train load has nearly doubled, subject, of course to local conditions of grades and operative conditions.

Mr. Basford shows in a most interesting manner the rapid increase in locomotive dimensions and weights. In 1888 Mr. M. N. Forney predicted that by 1918 the passenger locomotive would reach a weight of 200,000 pounds, while, as a matter of fact the weight passed 230,000 pounds in 1905. In 1900 Mr. Forsyth predicted that in 1905 freight locomotives of 311,000 pounds would be built, and this figure was passed by the construction of the Mallet articulated locomotive of 334,000 pounds weight last year.

"This rapid advance in weight and power is too general to be anything but a principle in American locomotive practice, and it is a principle which compels the most careful consideration and deepest thought of those who decide questions of design, as well as those who bear the responsibilities for other improvements in equipment and maintenance facilities, in the advance of which the locomotive now stands.

"Because of the increasing weights of cars and trains, we must have large and powerful locomotives. This fact seems to be sufficiently demonstrated. Whether they are in every respect popular or not, they constitute an economic necessity in present day conditions. It seems to be altogether improbable that there can ever be a pause in the advancement to more powerful units, and as long as the country supplies such increasing quantities of commodities to be moved, we can not go backward in the power to move them. There has been no backward step and no halting in the growth of the ocean liner, and for the same reason there can not be in the locomotive. Economical operation requires the heavy load. As the channels of the harbors must be dredged to depths of forty feet to pass great ships, and as the docks must be enlarged to receive them, so must the facilities for dealing with the large locomotive be provided. Having the large locomotive, we have the problem of designing, of operating, and of maintaining, to render its service satisfactory. No questions presented in previous years of locomotive development have ever been as important or as difficult as those now before us.

"The question is not, Shall the next order of locomotives be big ones? They *must* be big ones. That is settled beyond argument The question is, How shall they be built?"

Mr. Basford brings out a very important point, and one which has not been given sufficient consideration, namely, that the best results cannot be expected by increasing the size of the locomotive without making a corresponding improvement in the conditions under which it is used.

"In estimating the real value of the very powerful locomotive of the present time, as compared with the locomotives of twenty or more years ago, much beside the locomotive itself must be considered. In the foregoing question presented for discussion, the locomotive only is mentioned, and this is but one phase of the very great change which the railroad problem has undergone, and is undergoing. It seems perfectly fair to state, and perfectly easy to maintain, that the increased cost of operating large locomotives—where there really is an increase—is largely due to operating conditions and to operating facilities which have not

always grown proportionately. For example, the consumption of fuel while large locomotives are standing on sidetracks is becoming an item of importance, yet this is as nothing compared with the cost of other losses of time on sidings. Not infrequently freight locomotives average only five miles an hour in speed when actually on the road. Not infrequently the speed between stations will be up to the extreme limit of the capacity of the locomotive; and this will be followed by a half hour or an hour spent on the sidetrack. Even the four or six pounds of coal per square foot of grate area per hour necessary to keep up steam while on the siding is not a negligible quantity under present conditions."

The real question to-day is, Are other factors, which combined constitute the operation problem, advancing rapidly enough to provide the opportunity for securing the most advantageous results from the large locomotives?

ELECTRICITY IN MINING OPERATIONS.

THE INFLUENCE OF ELECTRIC POWER UPON ECONOMY, EFFICIENCY AND OUTPUT IN COAL MINING.

R. G. Mercer—Birmingham and District Electric Club.

IN a paper recently presented before the Birmingham and District Electric Club the question of the advantages of electrical transmission of power for mining operations, with especial reference to collieries was treated by Mr. R. G. Mercer. As the author well says, no industry calls for the transmission of power to greater distances and under more disadvantageous conditions, and no class of work exposes the machinery to rougher or more onerous usage than the mining industry. For these reasons steam, compressed air, and mechanical transmission are being rapidly superseded by electrical methods, which, besides giving increased reliability and freedom from breakdown, have been proved to be considerably more efficient and convenient, besides being less expensive in operation.

"Much has been written on the subject of electric winding, but little has been done in Great Britain with regard to the application of electricity to winding. This is probably due to the difficulty of coupling motors satisfactorily to existing drums. Steam winding engines, as at present used in this country, are among the most inefficient appliances about a colliery, owing to the large amount of power for starting and accelerating the load; the steam consumption of these engines per horse-power-hour of actual work done, in raising coal, varies from 50 lb. to 120 lb. or more in many cases. The most modern steam plant, even when fitted with automatic expansion gear and exhausting into a condenser, cannot compare with an electric winding plant from an economical point of view. The certainty and simplicity of control, and the handiness of electric winding gear, the uniform torque of the motors, which allows the flywheel effect of the winding engine to be reduced to the smallest possible amount, while a steam engine must in many cases have a greater flywheel effect, due to its reciprocating action, are strong recommendations."

The question of electric haulage in mines appears to have been settled in the affirmative by reason of the large practical success which has been attained both in the United States and elsewhere. While the cost of maintenance is less with electrical haulage than with any other method, the greatest economy appears in the question of reduced attendance. The replacement of steam haulage by electricity has in some cases enabled the output to be doubled, while the cost at the same time reduced to about one-tenth that of animal haulage.

Electric locomotives both for mine and surface haulage as at present constructed are thoroughly sound and efficient machines. In general the motors are of the steel clad enclosed railway type, the controllers have magnetic blow-outs which prevent arcing between contacts and are, together with the resistance and motor, specially designed and constructed for mining service. Standard sizes of these locomotives range from 16 H.P. to 100 H.P. or over, weighing respectively 2 and 13 tons.

The track gauge may be anything from 18in. upwards and the minimum height exclusive of trolleys, respectively, 32 in. and 36 in., so it will be noted what a very small amount of head room these locomotives require. Where rope haulage plants are already in use and where the conditions are not suitable for locomotives, the electric motor can with advantage replace the steam engine for driving the drum. When the endless rope system is employed a constant speed motor drives the drum continually in one direction. With the main and tail system two drums maye be connected to a reversing motor or to two separate motors. Where polyphase current is used it is advisable, unless a friction clutch be used, to operate the haulage gear by means of a slip-ring motor, the controllers and switches being immersed in oil of a high flash point. When a friction clutch is used, the squirrel cage motor can be used. The absence of sensitive parts is an immense advantage where motors are entrusted to the care of unskilled men and exposed to much dirt, dust or damp. The motor is as simple as a grindstone and will run continuously with no further attention than that required to fill the oil wells. It may be pulled up dead by extreme overload without injury, a thing impossible with any other type of motor; it is capable of developing a torque several times its normal full load torque and is therefore not liable to be stopped by momentary overload."

One of the earliest applications of electricity in mining operations was that of operating mining pumps. With the earlier, slow speed reciprocating pumps a double speed reduction was necessary to enable the motors to be connected. High-speed reciprocating pumps of modern design have since been designed, enabling electric motors to be attached with but a single gear reduction, the speeds of such pumps varying from 160 to 300 revolutions per minute, according to size.

"High lift turbine pumps are now being used extensively, the cost of making foundation and excavating rooms for them is less than for a reciprocating pump of similar capacity, because the turbine pumps operate at a very much higher speed (such a speed indeed that the motors have to be specially designed for running them), and consequently the pump and motor are very much more compact. There are no air vessels, there is no water-hammering in the pipes and the flow is continuous.

"The most important factor limiting the speed is the quality of the water passing through the pump; if the water is dirty and gritty the speed should be as moderate as possible, owing to the excessive wear of the internal parts of the pump if it is running at as high a speed as it can with clean water. It is impossible to fix any hard-and-fast rule about the relation of capacity to head, but generally speaking at ordinary speeds, to obtain the best results with a pump of moderate price, the number of gallons per minute should be about equal to the number of feet in total head. As an example, a pump designed to deliver 500 gallons per minute against a head of 500 ft. would give an efficiency of not less than 72 per cent, while the best efficiency possible with a pump designed to deliver 50 gallons against the same head would only be about 60 per cent. Where the conditions are such as demand variation in head, this can be easily obtained within certain limits by adopting a multistage turbine, arranged so that one or more of the impellers can be cut out, either by removing the impellers from the pump or by the use of a special bye-pass; should the quantity only require to be varied the result can generally be obtained with a little loss of efficiency by throttling the discharge. The very best type of motor for coupling up for turbine pumps is undoubtedly the squirrel cage motor, whose starting current is not excessive and will probably not exceed full load current."

We have already reviewed in these columns the experiments which have been conducted in Germany and Belgium upon the posibility of the ignition of mine gases by the sparks from dynamos and motors. This feature of the subject of electric driving in mines is one which is attracting much attention at present, and there is little doubt that the improvements which are continually being made in this respect will remove the restrictions which at first were found necessary.

In general it appears that the application of electric power in collieries means not

only a large reduction in the cost of the coal mined, but also an increased output and all-round better working conditions. A tabulation of the costs of mining power for various operations under the old system and the new in several collieries shows that the annual saving in consequence of using electric plant is so large as to enable the plant to pay for itself in a few years. There are other economies which are less easily reduced to definite figures than the fuel and labor items, and among these may be mentioned the possibility of centralising the power generating plant and most of the skilled attendants within the walls of a single building. This is of special advantage where several shafts are worked under the same management. A large reduction is effected in the cost of maintenance and repairs as compared with more antiquated machinery, and again, a safe, efficient, and economical means of lighting the mine is provided, this being a contingent advantage of the greatest value.

THE COMMERCIAL ENGINEER.

COMMERCIAL REQUIREMENTS IN PRACTICAL ENGINEERING WORK AND THEIR RELATION TO TECHNICAL EDUCATION.

W. Bardill—Birmingham Association of Mechanical Engineers.

SO much has been written and said of late about technical education that it might be thought that some tangible results were about due. Such results as have been attained are not wholly encouraging, and thoughtful men are beginning to wonder if the methods employed are altogether those best adapted to the purpose. The status of affairs in Great Britain is well set forth in a paper presented before the Birmingham Association of Mechanical Engineers by Mr. W. Bardill, from which we make some abstracts.

"When one pauses to think of the number of acts of Parliament that have been passed, the discussions on the education estimates, the number of codes that have been issued, the number and amount of rates that have been paid, the number of schools that have been built, the salaries that have been received, and the grumbling that has been indulged in, one is led to expect something in the shape of results. Yet, on the other hand, it is an absolute fact, which many can no doubt verify, that it is one the rarest events in one's business experience to secure a youth fresh from school who can address even an envelope so as to be decipherable at first glance, whilst for spelling and arithmetic, these are things which had better be left without comment. You question such a youth and ask him what he learned at school. He will tell you, perhaps, physiography, chemistry, a little French and German, and, perhaps, even Spanish. There is no wish on the part of any sensible person to decry this knowledge, but surely it is of much greater importance that a boy, on leaving school, should be able first to speak, and write in a legible hand the language of his own country, and also to be familiar with the elementary rules and tables of arithmetic which enter into the daily routine of common every-day life.

"This is a serious matter for the nation. In the few years betwixt 14 and 21 years of age a tragedy may be perpetrated, inasmuch as a youth has either made use of his knowledge and gone forth to hold his own in life's battle, or he has gone to join the ever-swelling army in this country of the unfit, the inefficient, or the unemployed.

"It is at this point that we will take him up and examine his prospects for promotion in the engineering profession. There is probably no question more troublesome to an average parent than to know what to do with our boys. It too often happens that because he has saved his pocket money and has purchased a model engine, or has taken the mangle to pieces, or the sewing machine, then the question is settled for ever — he must be an engineer. The course now open, according to the means of the parents, is clear, according to the accepted ideas. If wealthy, they will be advised to allow the boy to remain at the grammar school till say, he is 15, then to take a three-year's course at a technical school, by which time he is 18, then to take another three years as a premium apprentice at an estab-

lished engineering works. This is an excellent course for those who can afford it, although amongst specialists there is much disputing whether the college course should precede or follow the practical training of the shop. So far as can be seen from actual cases that pass under one's own observation, this point is not worth much discussion, as neither the one nor the other, with the usual exceptions to every rule, count for much".

It has been said that the engineering profession is overcrowded, that technically trained men are not what the employers want, that the product of the present educational institution is worse than useless in the workshop, and that his training has to be begun all over again before he is really worth his wages. That there is some degree of truth in these statements must be admitted, but such views cannot be wholly accepted.

"It r ight be put forward with a great degree of truth that a good deal too much money was being spent in such schools for the amount of good they were doing, *i. e.*, that their mechanical efficiency was low. It might also be put forward with an even greater degree of truth than in the first instance, that the teaching staff of some of the technical schools leaves something to be desired, especially so as the staff often consists far too much of the schoolmaster than the practical engineer or electrician, From considerable experience of those who have gone through such schools, an impression has grown that in many cases the professor or tutor has laboured most to demonstrate to his pupils what a wonderfully clever man he hin self was, rather than adapt himself to his pupils and give practical information. This is quite true, and in many cases it accounts for the many lapses in attendance at the various evening classes, and for the indifference to a large extent of the ordinary day student of the average technical school. The lectures are often enough right above the head of the average student, and they are often accompanied by an exhibition of intellectual fireworks which blinds the poor student.

" There is, of course, the exception of the odd youth who is anxious, and who, not satisfied with receiving those blinding flashes of truth so suddenly, buttonholes the professor on the quiet, before or after the lecture, and asks questions which enable the professor to speak quietly from his own natural good-hearted self, and the youth, by having thus had the current switched on gently, perceives by-and-by a faint glimmer of light, and he follows it and chases the professor till he really does understand what it all means. That youth is on the way to being a manager very quickly.

" Generally speaking, there is too much of the school, and too little of the shop in the technical schools. By that it is not meant that the schools do not possess large enough workshops or sufficient machine tools. On the contrary, there are too many of these, and what good is to be gained by teaching a draper's assistant to use a lathe, or a hairdresser's assistant to plane wood, is hard to say. The place to learn a trade is the shop itself, but the place to learn the science which lies behind the handicraft is the technical school.

What is meant is, that whilst we would not go the length of stating, as the proprietor of one of the largest and best-known engineering works in Great Britain once said, that 'professors were generally men who had been an absolute failure in business life, and were obliged to take to lecturing for a living,' yet it is a fact that both universities and technical schools have far too few successful engineers and business men amongst them."

There is no doubt that there is much room for improvement in the relation between the technical school and the shop, but that fact furnishes the best possible reason for pushing ahead in every way possible to improve the efficiency of the institutions to which it is realized that we must look for the material for the trained engineers of the immediate future. Closer relations should be established between the scientific school and the shop. Greater care taken to demand the appointment of professors and teachers who have had practical experience with the great manufacturing industries of the world, and above all ample opportunities should be given to the professors to show what is in them by permitting them to devote a reasonable amount of their time to outside practice. The American practice of having lectures delivered before students by men who are themselves in charge of

great manufacturing and engineering enterprises has been found of value in creating relations of value between the technical school and the productive workshop, and unless such relations can be created and maintained much of the work of the school will be vain.

"The employers of labour in Great Britain are being gradually forced to recognise that their future hopes are contained only in 'tariff reform' but in that one word which means so much, "efficiency." Therefore, at whatever risk and at whatever cost, the employer is or will be forced to make up his mind that whatever is inefficient, no matter how it is endeared to him by ancient associations or happy recollections, must go, and whether it be inefficient staff, inefficient workmen, inefficient power, or inefficient plant, down they must come, and if he be wise, to that plaintive song 'Woodman spare that tree,' he must turn a deaf ear, and with the energy of a Gladstone he must ply the axe till those forces which now hinder his development are severed for ever. To fill the gaps thus made his only chance is to transplant young shoots, and whether they be grown in the technical school or in the employers' own forcing house, it matters not; so long as they are full of sap and energy he will be well repaid for his sacrifice."

ELECTRIC DRIVING OF MACHINERY.

PRACTICAL NOTES UPON THE INSTALLATION OF ELECTRIC MOTORS FOR OPERATING TOOLS AND MACHINERY OF VARIOUS CLASSES.

W. J. Belsey—Institution of Electrical Engineers.

AT the present time the discussion upon the employment of electricity as a means of transmitting and applying power is no longer confined to the comparison of advantages between electric driving and other methods; the advantages of electricity are practically admitted and the real question is not: Shall we use electricity? but rather: How shall we use electricity? It is to furnish the answer, or rather the answers to this latter question that we abstract a paper presented before the Dublin local section of the Institution of Electrical Engineers by Mr. W. J. Belsey, giving notes upon the subject of driving machinery of various kinds by means of electric motors.

A problem which almost invariably confronts us in the laying out of an electrical drive is to determine whether the machines should be driven individually or in groups, and unless one has a most intimate knowledge of the working conditions which obtain, it is most difficult to say which is the best. As a general rule, individual driving is about fifty to sixty-five per cent greater in the first cost than group driving. The advantages of individual driving are well marked, in that each machine is an independent unit and can be run without respect to the other machinery. The liability to break down is considerably lessened, and full advantage can be taken of the stops or intermittent working of the machine, current being only taken when the machine is in use and only in proportion to the work done. The advantage of a group drive is principally in the low first cost. In the majority of cases, however, the problem resolves itself into a compromise, the larger machines being driven by individual motors and the smaller ones grouped together in small groups driven from short lines of shafting. The question of a proper grouping is one which merits very serious consideration, as on it very often depends the financial success of an installation.

Mr. Belsey takes up the operation of factories of different kinds, beginning with the textile industries. Considering first the operation of spinning, the primary consideration is that of the maintenance of a predetermined constant speed, in order that there may be uniformity in the product and a minimum of broken ends. For these reasons it will be evident that the induction motor is best suited for the operation of spinning frames, for its speed with a given load is constant with respect to the speed of the prime mover, and as the load on spinning frames varies but slightly whether empty or full, it may be said that if driven by an induction motor the speed

of the frame will be constant with respect to the speed of the prime mover. The speed of a shunt-wound direct-current motor is not by any means solely dependent upon the speed of the prime mover, for it varies, depending upon whether the motor is hot or cold, and the difference in speed with a continuous-current motor, cold and hot, is generally about five to ten per cent, say eight per cent as a fair average, and it takes from two to four hours (depending on the size) for a motor, starting cold, to reach its maximum speed. This means loss in production. Of course, these difficulties could be overcome if we fixed shunt regulators on to the motors and generators, but if the mill manager did this he would be taking the production out of the hands of the management and giving it to the operators, which, to say the least, would be unwise, and a condition which no mill manager would consider for a moment. Again, the atmosphere of a spinning mill is invariably charged with fine lint dust and fibre, which has a most deleterious effect on the commutators of direct-current machines, and this in itself is sufficient to preclude the adoption of direct-current machines for this class of work. Also, as every available square foot of floor space is occupied by producing machinery, the motor is generally located either on a platform hung from the ceiling, or is bolted direct to the ceiling in an inverted position.

A group system of driving is generally adopted for spinning mills. The motor is usually of a large capacity, ranging from seventy-five horse-power to 150 horse-power, and is direct-coupled to the line of shafting, from which are driven a number of machines by means of belts. The overall efficiency of this method is equal to that of the individual drive, notwithstanding the use of belt transmission to the individual machines. This is due to the much higher efficiency of the larger motors, as compared with the efficiency of the smaller motor used on the individual drive system. A disadvantage of the group system, however, is that it is practically impossible to vary the speed of the individual frames while they are in operation. The same remarks as to the suitability of alternating-current-induction motors apply in a somewhat lesser degree to the other operations in a spinning mill, such as carding, breaking, hackling, spreading, etc.

In the other departments of textile work the conditions vary. For operating looms the maintenance of a maximum uniform speed is desirable and here again the induction motor is suitable. The operation of bleaching, finishing, and printing, on the contrary demand a convenient and economical speed control, thus indicating the use of direct-current motors, and since the machines demand from twelve to fifty horse-power, independent driving is applicable.

Coming to the subject of machine shops and foundries, Mr. Belsey believes that the continuous-current motor is generally best adapted for machine-shop service, and thinks that in general it pays to use individual driving for any machine requiring more than five horse power.

The author gives a series of tables indicating in a general way the power required by machine tools of different kinds, but unless the speed and the nature of the work are known, such estimates can be only of the most general character. As has been shown elsewhere, a fair criterion of the amount of power required is that of the weight of material removed in a given time, and in this case also, the condition and character of the cutting tool exercises an important influence upon the power consumption.

In the foundry the induction motor is to be recommended, since there is no demand for a variable speed, while the dusty condition of the surroundings renders it very desirable to dispense with the commutator.

An important department of work to which electric driving may be applied to advantage is that of working upon plate and structural steel. This includes both shipbuilding and general structural work, and the conditions demand somewhat various requirements to be met.

Undoubtedly for punching and shearing machines, induction motors are the best suited, principally on account of their very robust construction and also because an induction motor can exert a much higher torque than a direct-current motor when suddenly required—as in the case of the

actual moment of shearing and punching—without an appreciable variation of speed. The speed of punching varies from about twenty-eight strokes per minute in the larger punches for one and one-half-inch-thick plates to about forty strokes per minute in the smaller ones, three-quarter inch plates. It is not generally considered good practice to exceed these speeds, as, if higher are used, the squad just misses a stroke, and therefore reduces the actual speed of punching by half. If direct-current machines are used, they should be compound-wound. Angle cutters and beam punches all have the same charcteristics as the above.

For plate binding rolls and mast rolls the motors should have the same characteristics as a railway or crane motor—*i. e.*, they should be series-wound and be capable of exerting a high torque when required. Plate roll motors are generally fitted with a brake attachment for convenience of adjusting the rolls. Although the series motor is undoubtedly the best suited for this class of machine, yet induction motors have been used with very considerable success for driving them, and on the north-east coast nearly all machines are driven by three-phase motors.

For the smaller machines used in structural steel works the same conditions apply as in the general machine shop, and direct-current machines are applicable. Individual motors are usually the best owing to the freedom given in the placing of the tools where they can be worked to the best advantage.

Mr. Belsey discusses at some length the application of electric driving to rolling mills, with especial reference to the sudden and heavy shocks for which provision must be made. It is evident in such service that some provision must be made for storing and giving out energy, and this may be done either by using a battery of accumulators or by employing a buffer machine for storing the energy in a heavy fly wheel. The system advocated by Mr. Belsey includes the use of a variable-speed dynamo, upon the shaft of which is fitted a heavy fly wheel, this machine acting as a motor or a generator according as it is receiving or giving out power.

THE STEAM ACCUMULATOR.

PRACTICAL EXPERIENCE IN THE USE OF INTERMITTENT DISCHARGES OF EXHAUST STEAM IN THE LOW-PRESSURE TURBINE.

A. Heller—Verein Deutscher Ingenieure.

WE have already referred in the pages of this magazine to the remarkable experiments of Rateau in connection with the development of the low-pressure steam turbine, especially in connection with the utilization of exhaust steam from large reciprocating engines. It is well known that in many cases it is impracticable to apply well-established principles of economical working to reciprocating engines owing to the controlling conditions under which they must be operated. Thus in the case of winding engines for deep mine hoisting, the irregularity in the load and speed, and the necessity for keeping the control of the machine wholly in the hands of the attendant, render it practically impossible to introduce the methods of automatic cut-off and multiple expansion so necessary to maximum steam economy. Similar conditions exist in the case of rolling-mill engines, the intermittent nature of the load in this case giving rise to very marked fluctuations of the pressure and volume of exhaust discharge.

In an article by Herr A. Heller in a recent issue of the *Zeitschrift des Vereines Deutscher Ingenieure* there is given an interesting account of the results which have been attained in Germany with the steam accumulator and the low-pressure steam turbine, this supplementing in a very effective manner the work which has been done in similar directions in France.

The principle of the steam accumulator is very simple, consisting in the provision of a sufficient mass of some heat absorbing material, such as iron, or water, this receiving the heat of the exhaust steam when it is in excess of the average and giving it out when the temperature falls, forming what may, by analogy, be termed a sort of

thermal fly-wheel. There is thus a vessel which receives the intermittent discharges of exhaust steam from the reciprocating engine and gives out a flow of steam of practically uniform pressure, suitable for the operation of a turbine especially designed for the purpose.

The field for such an appliance will be realized when it is understood that there are now in operation a large number of reciprocating engines discharging their exhaust into the atmosphere, and necessarily operating in such a wasteful manner as to cause steam consumption rates of 80 to 100 pounds per horse power per hour. It is well known that such conditions are most undesirable, but, as in the case of winding engines, or of rolling-mill engines, the demands of the service preclude the introduction of methods generally in use to effect better economy. In such plants the steam accumulator appears to have a legitimate field for its operation.

The plants installed by Rateau at the Bruay mines (Pas de Calais) and at the Reunion mines in Spain, have already been described in the issue of this magazine for October, 1903. At the Düsseldorf exposition the system was displayed by the German builders, Messrs. Balcke & Co., of Bochum, and this firm has recently installed the method in the Poensgen Iron Works, where it has now been in operation for about a year.

The accumulator at Poensgen receives the exhaust steam from a set of reversing plate rolls, several steam hammers, and from the air and circulating pumps for the central condensing plant, the total amounting 8,000 to 10,000 kilogrammes of steam per hour.

The general arrangement of the plant is similar to that of the mines at Bruay. The exhaust steam from the various engines, and other cylinders is delivered to the accumulator, this being a cylindrical vessel 8 metres in height and 4 metres in diameter, containing a series of cast iron buckets, or boxes in which the water of condensation accumulates whenever the temperature falls below the average and from which it evaporates into steam when the temperature rises. The exhaust steam enters this vessel from below, and the passages are so arranged that it comes in contact with all parts of the chamber and the water boxes, and passes out at the top of the turbine. The metal and the water become heated to the average temperature of the exhaust steam, and the processes of heat absorption and return go on continually in the interior, with the result that the discharge of steam at the outlet is almost uniform, regardless of the irregularities in the delivery at the inlet. Thus, the pressure of the exhaust steam delivered to the accumulator did not vary more than about 0.1 atmosphere. The low-pressure turbine, of the Rateau type, directly connected to two direct-current dynamos, delivered power varying according to demand from 100 to 400 kilowatts, running steadily, either in parallel or in series, according to the desired voltage, and deriving its power from steam formerly entirely thrown to waste.

Herr Heller gives reproductions of diagrams from pressure recorders to show the uniformity in steam pressure maintained in the accumulator, notwithstanding the irregularity in the sources of supply, and also gives details of the pressure regulating valves used in the connections of the apparatus.

Illustrations are also given of later types of accumulators, in which the heat absorption is effected wholly by a mass of water contained in a tank, the exhaust steam circulating through flues in the water, the variations in admission pressure being equalized by the varying rate of evaporation of the water in the tank so as to maintain practical uniformity in the discharge pressure to the turbine.

In nearly every case it is found desirable to use the power obtained from the exhaust steam to generate electric current, for which numerous uses can be found about mining plants or in rolling mills. There are numerous applications for electric motors in both departments of work, while electric lighting is always available, and when such applications of energy can be found there is every reason to install a simple mechanism for utilising the waste power at present escaping in the exhaust steam.

It is a matter of interest to note that the low-pressure steam turbine, exhausting into a vacuum, is a machine of excellent efficiency, practically as good as that of the

high-pressure turbine, while the efficiency of a reciprocating engine at such pressures is very low. With the use of the steam accumulator it is practically possible to arrange a compound set in which the high-pressure portion consists of all the irregular running high-pressure machinery about the place, including winding engines, hammers, pumps, and other engines in which the conditions require the admission of high-pressure steam during the larger part of the stroke, the combined exhaust of the whole lot being delivered to an accumulator from which issues a smooth, continuous flow of steam to a turbine of high efficiency, producing electric current for lighting, auxiliary power, and all the manifold service of which it is available. without the consumption of an additional pound of fuel.

There has been some doubt as to the correctness of the statement as to the high economic performance of the steam turbine, using steam at pressures but slightly above that of the atmosphere, but M. Rateau seems to have demonstrated this fact beyond doubt by tests upon actual installations. Thus, tests of a 300 horse power low-pressure steam turbine of the Rateau type at the Bruay mines with steam pressures ranging from 0.845 to 1.034 atmospheres absolute the steam consumption ranging between 17 to 18 kilogrammes per horse power per hour. Even when the load was thrown off, and the steam pressure dropped to 0.659 atmosphere, the steam consumption was only about 19 kilogrammes per horse power per hour. Of course it is not practicable to obtain such high economical performances at these low pressures as at pressures of 10 to 12 atmospheres absolute. Thus, with an initial pressure of 11 atmospheres absolute, or about 150 pounds per square inch, the Rateau steam turbine at Penarroya showed a steam consumption of only 6.74 kilogrammes per horse power per hour, developing 641 horse power, with a vacuum of 0.128 kilogrammes per square centimetre absolute or 1.82 pounds per square inch.

In installations in which the steam accumulator is used in connection with the exhaust steam from winding or rolling-mill engines for the supply of electric current for lighting or similar service, it is necessary to install also an auxiliary machine to be used with live steam direct from the boiler in case the main engines are stopped for any reason.

ELECTRIC LOCOMOTIVES FOR THE SIMPLON TUNNEL.

DETAILS OF THE ELECTRIC TRACTION EQUIPMENT OF THE SWISS FEDERAL RAILWAY SYSTEM IN THE SIMPLON TUNNEL.

S. Herzog—Le Génie Civil.

THERE is little doubt that the strongest influence in leading the operators of main line railways to consider electric traction is its preëminent suitability for use in tunnels and subways. Even in short tunnels the presence of gas and smoke has proved a great nuisance, while in the long subways of modern great cities steam traction would be out of the question. The London underground system long suffered from the difficulties due to steam traction, and has now taken a new lease of life with the introduction of electricity. In New York the difficulties and disasters in the tunnel of the New York Central Railroad have led to the conversion, now well under way, of the system to electric traction, this extending to about thirty miles out of the city, and there is little doubt that the presence of the tunnel will prove to have been a blessing in disguise, bringing about the change from steam to electricity far earlier than would have otherwise been the case.

In regard to the great Alpine tunnels the experience has been variable. The Mont Cenis route has always been smoky and troublesome, but until lately the intervals between trains have been sufficiently great to render any change unnecessary. On the St. Gothard route there appears to have been a sufficient difference in atmospheric pressure between the two sides of the Alps to cause a fairly effective current of air through the tunnel but with the increasing frequency of trains this has been insufficient to clear the route from gases and smoke, and the Saccardo system of mechanical ventilation has been success-

fully introduced as described in these columns several years ago.

In the design of the Simplon tunnel as we have frequently described during the course of the work, the auxiliary tunnel, connected at frequent intervals with the main passage, affords ample opportunity for ventilation, and at first it was intended that steam locomotives should be employed in this as in the other Alpine tunnels. During the time required for the completion of the Simplon tunnel, however, the development of electric traction on railways has been such as to cause the original plan to be abandoned. Especially had the success with the three-phase traction on the Valtellina line of the Adriatic system in Northern Italy drawn attention to the subject, while the existence of power generating plants in connection with the construction works on the tunnel also aided in making the decision as to the employment of electric locomotives in the operation of transportation through the tunnel from the very commencement of the service.

In a recent issue of *Le Génie Civil* there is given a detailed account of the electric locomotives now under construction for the tunnel service, and from this paper, by Mr. S. Herzog we give some description of these important machines.

Since the short space of time remaining between the decision to use electric traction and the opening of the tunnel rendered it impracticable to have the new locomotives completed in time it was decided to make use of an offer of the Italian Adriatic Railway System and accept the use of two electric locomotives, built by Brown, Boveri & Co., of Baden, and intended to be added to the equipment of the Valtellina railway. These engines, designed for three-phase current at 3,000 volts, 15 periods, are to be put into regular service in the tunnel on June 1, of this year, at which date the regular train service is to be inaugurated.

The original specifications for the Valtellina locomotives provided for a chassis mounted on two bogie trucks, and two driving axles, the load on each driving axle not to exceed 14 metric tons, and no gearing to be used between the motors and the driven axles of the locomotive. Two normal speeds were to be provided, the speed change to be made by pole commutation, the normal speeds to be 30-40 kilometres, and 60-70 kilometres per hour, or say 25 and 40 miles. At these speeds the tractive power should be not less than 6,000 kilogrammes at the low speed, and 3,500 kilogrammes at the high speed. The period of acceleration from standing to a speed of 30 kilometres, on a level track or up a grade of less than 0.1 per cent, with a train of 400 tons, including the locomotive, was specified to be within 55 seconds. A train of 250 tons, under the same conditions, was required to attain a speed of 60 kilometres in 110 seconds. A speed of 30 kilometres was required with a train of 250 tons, up a 2 per cent grade. The specified efficiencies were 85 per cent at the high speed, and 80 per cent at the lower speed, and the motors were required to keep at a temperature not exceeding 40 degrees C. above the surrounding air, even with an overload of 100 per cent during 200 seconds, or an overload of 50 per cent during an hour. During a run of ten hours under full load at either of the normal speeds the temperature of no part of the machine, including the bearings of any portion of the motors, should exceed 60 degrees above that of the atmosphere.

These requirements were followed in general, except that the design was modified to permit the use of three driving axles, the two motors being raised above the locomotive axles, and connected to the drivers by a triple-headed parallel connecting rod.

The general structural details of the two locomotives now to be put into service in the Simplon tunnel are fully illustrated in the article of M. Herzog but some of the principal points may be given here. The total weight is 62 tons, of which 42 tons are carried on the drivers, these latter being 1.64 metres in diameter, and the total length of the engine 12.32 metres. The normal power of the two motors is given as 900 horse power, and the maximum as 2,300 h, p, or 1.150 h. p. per motor, and this, for a weight of 10.75 tons for each motor represents the minimum weight for the power which has yet been attained.

In the Ganz system, used in the earlier Valtellina locomotives the speed change was effected by the arrangement of the motors

in cascade, and this method is still to be employed in the new engines now under construction by the same firm. In these locomotives by Brown, Boveri & Co., however, a saving in weight of 2.5 tons per motor has been made by abandoning this system and producing the speed change by varying the number of poles in the stator; by changing from 16 to 8 poles the velocity is changed from 112 to 224 revolutions.

The general arrangement of the contacts for taking the current is similar to that used on the Valtellina locomotives except that the sliding contact trolley arms are so arranged that they can be lowered to the horizontal position when in the tunnel, thus bringing all parts of the locomotive within the normal loading gauge of the Swiss and Italian railways.

At the present time the electric current is to be furnished by the hydro-electric stations at Brieg and Iselle, situated on the Rhone and on the Diveria, their respective capacities being 1200 and 1500 horse-power. It is estimated that trains passing from north to south will require 20 minutes in passing through the tunnel, and 30 minutes in going the opposite direction, the latter traverse being the slower because of the up grade.

There can be little doubt as to the wisdom of making the change from steam to electric traction, so far as the Simplon tunnel is concerned, from the very start. The advantages of the route, so far as the shortening of distance between Italy and the North Sea ports will appear immediately, but France cannot expect to reap the benefit which should be hers until some definite settlement as to the connecting routes is made, and even after the plans have been accepted there will remain much construction work to be done. There is no question, however, that passenger traffic would be largely directed toward the route which offered electric traction through the long tunnel, and assured immunity from the smoke and gas now so oppressive in the Mont Cenis tunnel, and rapidly becoming a nuisance also in the St. Gothard. Probably the influence of the change will be felt on these older routes as well, and we may soon expect to hear of the electrification of both of the earlier tunnels, to the increased comfort of travellers by all routes.

Similar results may be expected upon the railways of northern Italy, where the example of the Valtellina line has already demonstrated the feasibility of electric traction. The great number of tunnels necessary in crossing the Apennines, and the material discomfort to tourists and other travellers through one of the most attractive regions of Europe over present routes, cannot but render the introduction of smokeless traction inevitable. When to these inducements is added the fact that abundant sources of hydraulic power await development and direction, in a country entirely lacking in coal resources, the situation is seen to be ripe for the transformation.

The contest between direct and alternating currents for main-line traction will doubtless be settled by the severe test of experience, and in the Simplon tunnel as on the Valtellina lines the three-phase system will show its worth, while, before very long the capabilities of the direct current for heavy main-line traction will be demonstrated on the New York Central Railroad.

In Switzerland the whole subject of electric traction on main-line railways has been placed in the hands of a government commission, and this commission has made a preliminary report, based upon an examination of the Burgdorf-Thun line, using an alternating current low-tension system; the Fribourg-Monet-Anet line, using direct current with third rail; the Valtellina line, above referred to, and using high-tension three-phase current; and the Milan-Gallarate-Porto Ceresio line, employing low-tension continuous current.

A study is at present also being made of the operation of the Paris Metropolitaine, and of the electric operation of the Paris terminus of the Orleans railway. The next studies will be of some of the German lines, with especial reference to the possibilities of the single-phase system, and not until these various studies have been worked out can a final report be expected, the present report being only a record of the work now being conducted in connection with these comparative examinations.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author.
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Anchorage.

Excavating and Concreting the New York Anchorage of the Manhattan Suspension Bridge. Illustrates and describes methods. 2500 w. Eng Rec—March 3, 1906. No. 75404.

Arches.

Computations for Arches Fixed at the Springings (Note Sur le Calcul des Arcs Encastre's). M. Pigeaud, Develing formulas from which working tables are computed, enabling the computations for arches rigidly built into the springings to be made by inspection. 6000 w. Ann d Ponts et Chaussées—2 Trimestre, 1905. No. 75773 E + F.

Computations for Single-Span Arches (Berechtonung von Eingespannten Gewölben). E. Mörsch. A mathematical treatment, giving analytical and graphical solutions according to the elastic theory. Two articles. 4000 w. Schweiz Bauzeitung—Feb. 17, 24, 1906. No 75750 each B.

We supply copies of these articles. See page 319.

Construction Methods at the Stone Bridge at Hartford, Conn. There are seven elliptical arches of 119 to 68 feet span of cut granite. Details of the centerings and the very effective methods of erection are given. 1500 w. Eng Rec—March 3, 1906. No. 75403.

The Danville Arch Bridge of the Cleveland, Cincinnati, Chicago & St. Louis Railway. An illustrated detailed description of a double-track reinforced concrete bridge of unusual design and its construction. 4300 w. Eng Rec—March 3, 1906. No. 75385.

The Graphical Construction of Parabolas of the Fourth Degree (Tracé Graphique des Paraboles du Quatrième Degré). Farid Boulad. A discussion of the relation of the parabola to the lines of influence of arches, and to the shearing stresses on beams. 7000 w. Ann des Ponts et Chaussées—3 Trimestres, 1905. No. 75775 E + F.

Bascule.

Strauss Bascule Bridges. Two designs of trunnion bascule bridges are illustrated and described. 800 w. R R Gaz—Vol. X. L., No. 11. No. 75553.

Buckling.

The Permissible Stresses upon Iron Bridge Members with Reference to their Resistance to Buckling (Zur Frage übe, die Zulässige Inanspruchnalime Eiserne Brückenorgane hinsichtlich des Widerstandes gegen das Zerknicken). Joh. E. Brik. An examination of the buckling stresses in framed structures, deriving formulas and tables for practical use in bridgebuilding. 4000 w. Oesterr Wochenschr f d Deffent Bandienst—March 3, 1906. No 75764 D.

Curved Trusses.

Computations for Curved Bridges (Calcul des Ponts Courbes). M Résal. A discussion of the stresses in bridges in which there is a horizontal curve between piers; with especial reference to the cross strains. 5000 w. Ann des Ponts et Chaussées—4 Trimestre, 1905. No. 75780 E + F.

Erection.

Erecting the Floor Systems and Lower Part of Trusses, Island Span, Blackwell's Island Bridge, New York. Illustrated detailed description of the sequence of operations. 1500 w. Eng Rec—March 17, 1906. No. 75571.

Erection of the Upper Part of the Trusses of the Island Span of Blackwell's Island Bridge, New York. Illustrated description of the work. 2200 w. Eng Rec—March, 3, 1906. No. 75399.

The Erection of the Miramichi Bridge. A truss bridge for the Intercolonial Railway across the southwest branch of the river, above Newcastle, New Brunswick. Six 204 ft. spans on stone piers. Completed spans floated into place in pairs on scows. 1300 w. Eng Rec—March 24, 1906. No. 75685.

Highway Bridge.

The New Portland Bridge. H. A. Crafts. Replacing an old bridge across the Willamette River, Portland, Oregon. One 200 ft. skew span, two 269 ft. common span, and a 384 ft. draw span, all steel trusses. Some difficult work with pile foundations for piers is discussed. 1000 w. Eng Rec—March 3, 1906. No. 75391.

Reconstruction.

Rebuilding the Housatonic River Bridge of the New York, New Haven & Hartford at Sandy Hook, Conn. Extract from a paper by A. H. Terry, before the Conn. Soc. of Civ. Engrs. on speed of constructions as illustrated by methods employed in replacing Bridge No. 105. Ills. 1800 w. R R Gaz—Vol. XL., No. 13. No. 75836.

Reinforced Concrete.

Arch Rib Bridge of Reinforced Concrete at Grand Rapids, Mich. George Jacob Davis. A type unusual in the United States, having reinforced slabs imbedded in the haunches, forming a pair of cantilevers. 2000 w. Eng News—March 22, 1906. No. 75647.

Ferro-Concrete Viaduct at Gennevilliers, near Paris. Illustrates and describes a viaduct erected to carry the branch of railway connecting the new gas works with a quay. It consists of 22 spans. 1000 w. Engng—Feb. 23, 1906. No. 75372 A.

Parabolic Reinforced Concrete Arch Bridge at Wabash, Ind. Illustrated description of a highway bridge having a rather unusual curve of the arch ring, a parabolic arc, and very complete reinforcement of the spandrel walls. 400 w. Eng News—March 15, 1906. No. 75527.

The Third Street Reinforced Concrete Bridge, Dayton, Ohio. Illustrated detailed description of the construction of a seven-span bridge on the Melan arch system. 2500 w. Eng Rec—March 24, 1906. No. 75682.

See also Civil Engineering, Construction.

Swing Bridge.

The Operation of the New Railway Bridge at Velsen (De Bewegings en Bedieningsinrichtingen der Nieuwe Spoorbrug te Velsen). J. J. W. van Loenen Martinet & F. C. Dufour. A detailed description of the swing bridge over the Noordzee Canal at Velsen, Holland, including the electrical operating mechanism. 4000 w. De Ingenieur—Feb. 17, 1906. No. 75782 D.

Transporter.

The Transport Bridge at the Old Port at Marseilles (Pont a Transbordeur sur

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le Port-Vieux à Marseille). G. Leinekugel le Cocq. Illustrating the erection and operation of a bridge of the transporter type on the Cantilever principle, with a clear span of 165 metres. Serial, Part I. 3000 w. Géine Civil—Feb. 24, 1906. No. 75715 D.

Wabash.

The Wabash River Bridge at Terre Haute, Indiana. Malverd A. Howe. Illustrated description of a new highway bridge having a rather unusual combination of trusses and plate girders. 2000 w. Eng News—March 8, 1906. No. 75438.

CONSTRUCTION

Building Construction.

Construction of the Title Guarantee and Trust Company Building, New York. The sand foundation is enclosed on all sides by sheet steel piling, and the cantilever beams for the support of the steel cage rest on an extensive grillage and concrete foundation. Ill. 3000 w. Eng Rec—March 17, 1906. No. 75574.

Extension of the Metropolitan Life Insurance Building, New York City. Describing the completion of the third section, with especial reference to the structural steel work and the reinforced concrete floor work and fireproofing. 3000 w. Eng Rec—March 3, 1906. No. 75409.

Building Details.

Special Column and Girder Details in the Office Building of the New York Central Lines. Describes the arrangements for excessive loads in a building that will have 20 stories when completed. 2000 w. Eng Rec—March 17, 1906. No. 75572.

Cement Pipe.

Method and Cost of Constructing Cement Pipe in Place. Halbert P. Gillette. Briefly describes the invention of Ernest L. Ransome, and the construction work, giving a report of cost. 1200 w. Eng Rec—March 10, 1906. No. 75479.

Concrete.

A large concrete Gas Holder Tank. A sunken concrete tank for a 5,000,000 cu. ft. gas holder recently built at the foot of 136th St., New York City, is illustrated and described. 2500 w. Eng Rec—March 3, 1906. No. 75394.

Erection.

Methods of Raising an Elevated Railroad Structure. Brief illustrated description of an interesting and rather unusual piece of work in progress in Chicago. 1500 w. Eng Rec—March 3, 1906. No. 75395.

Excavation.

Excavation for Dry Dock No. 4, Brooklyn Navy Yard. Describes this dock, now under construction, and the very difficult conditions to be met; also the preparations made to avoid trouble and delays. Ills. 2800 w. Eng Rec—March 3, 1906. No. 75398.

The Novel Methods of Excavating Building Sites in Chicago. Describes the methods adopted in order to enable contractors to employ the subway freight tunnels for the removal of material. Ills. 3000 w. Eng Rec—March 10, 1906. No. 75476.

Floors.

The Economical Design of Reinforced Concrete Floor Systems for Fire-Resisting Structures. Discussion of a paper by John S. Sewell, on this subject. Ills. 20500 w. Pro Am Soc of Civ Engrs—March, 1906. No. 75835 E.

Foundations.

Building and Machinery Foundations in Quicksand. Illustrates and describes methods used in building foundations for the Knickerbocker Building at 114 and 118 West 39th St., New York City. 2700 w. Eng Rec—March 3, 1906. No. 75388.

Substructure for the United States Express Company's Building. A 23-story building on Greenwich St., New York, which involved considerable difficulty in building the substructure, the foundations being carried through water and quicksand to rock at a depth of 41 ft., is illustrated and described. 4300 w. Eng Rec—March 3, 1906. No. 75411.

Grain Elevator.

New Grain Elevator for the Santa Fe System at Chicago. Illustrated description of a new elevator under construction, which possesses unique features of interest. 1100 w. Ry Age—March 23, 1906. No. 75811.

Reinforced Concrete.

Erection of a Reinforced Concrete Factory for the Bush Terminal Company. Illustrates and describes details in construction of this 75x300 ft. seven-story building in South Brooklyn, N. Y. The floors are calculated for loads of 800 lbs. per square ft. 2500 w. Eng Rec—March 3, 1906. No. 75400.

Formulas for Reinforced Concrete Beams. Henry Goldmark. Considers the advantages and objections of reinforced concrete, and the methods for calculating the stresses in reinforced concrete beams. 6800 w. Can Soc of Civ Engrs—Feb. 22, 1906. No. 75618 D.

Reinforced Concrete and Tile Construction, Marlborough Hotel Annex, Atlantic City, N. J. Illustrated detailed description of a building in which the framework, including columns, girders and roofs, is reinforced concrete, while the walls and floor filling are burnt clay hollow tile. 3500 w. Eng News—March 8, 1906. No. 75434.

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Reinforced Concrete Suburban Residence Construction. William F. Tubesing. Illustrates two residences in the vicinity of Cincinnati, O., describing one in detail. 1100 w. Eng News—March 1, 1906. No. 75302.

The Design of Concrete Steel Beams and Slabs. Edward Godfrey. Aims to show that formulas for concrete-steel beams or slabs can be made as simple as those for steel beams. Discusses principles of design. 4000 w. Eng News—March 15, 1906. No. 75528.

The Determination of the Sliding Resistance in Reinforced Concrete Beams. Prof. Ramisch, in *Zeitschr, d Oesterr, Ing. Arch. Ver.* Discusses the proper method for the determination. 2000 w. Cement—March, 1906. No. 75613 C.

The Northwestern Ohio Bottle Company's Factory. Illustrates and describes a main building and a coal shed of the Ransome reinforced concrete construction. 1600 w. Eng Rec—March 24, 1906. No. 75688.

The Reinforced Concrete Factory for the American Oak Leather Co., Cincinnati. Sanford E. Thompson. Illustrated description of structural details of interest. 2500 w. Eng Rec—March 3, 1906. No. 75412.

The Shearing Resistance of Reinforced Concrete. S. Zipkes. Describes tests conducted by the writer dealing with the shearing resistance of plain and reinforced concrete. Ills. 1800 w. Cement—March, 1906. Serial. 1st part. No. 75612 C.

See also Civil Engineering, Bridges.

Roads.

Building a Marsh Highway near New York. Illustrated description of the construction of a road through a salt meadow, which is a part of an inlet from Long Is. Sound. 1200 w. Eng Rec—March 3, 1906. No. 75390.

Mountain Road Construction in Idaho. E. B. Darlington. An account of a system inaugurated to build mountain roads on engineering principles, and planned along systematic lines. 1800 w. Eng News—March 15, 1906. No. 75522.

The Corniche Road in the Maritime Alps (La Corniche de l'Estérel). M. Thérel. A historical and technical description of the construction of the famous Corniche road along the Riviera in the South of France. 15000 w. 2 plates. Ann d Ponts et Chaussées—2 Trimestre, 1905. No. 75770 E + F.

Roofs.

Traveling Stages for Removal of Roof at Charing Cross Station. Illustrates and describes the method of removing this large roof and replacing by a different type, without interrupting traffic. 800 w. Engng—March 9, 1906. No. 75601 A.

Sanitation.

Sanitary Building Construction. Alfred Saxon Snell. Read before the Roy. San. Inst. Discusses conditions affecting the health that should be considered in building. 4000 w. Plumb & Dec—March 1, 1906. No. 75539 A.

Shoring.

Difficult Shoring Work for Buildings in Chicago. Explains conditions and illustrates and describes difficult work in erecting the Boston Store in the retail business district. 2700 w. Eng Rec—March 24, 1906. No. 75686.

Specifications.

Iron and Steel Structures. Abstract of a report presented at meeting of the Am. Ry. Engng. & Main. of Way Assn., with general discussion. Considers specifications for steel bridges, loads, strains, designs, &c. 23500 w. Ry Age—March 23, 1906. No. 75821.

Subway.

See Street and Electric Railways.

Tall Buildings.

American Tall Buildings or Sky-Scrapers (Amerikanische Hochbauten Sogenannte Wolkenkratzer). F. Bohny. An illustrated description of the tall business buildings of the United States, with especial reference to Chicago and New York. Serial, part 1. 3500 w. Zeitschr d Ver Deutscher Ing—Feb. 24, 1906. No. 75704 D.

Tunnels.

The Construction of the Simplon Tunnel (Der Bau des Simplon tunnels). F. Pflug. Including a description of the surveys, rock drilling machinery and masonry work. Serial, Part I. 2000 w. Glasers Annalen—March 15, 1906. No. 75753 D.

The Construction of the Simplon Tunnel (Les Travaux du Tunnel du Simplon). M. Jacquier. A general description of the undertaking and its difficulties; reviewing the engineering peculiarities of the work, with statistics of the execution. 20000 w. 1 Plate. Ann d Ponts et Chaussées—4 Trimestre, 1905. No. 75777 E + F.

The New York & Long Island Railroad Tunnel. Information concerning the laying out of a double-track tunnel under the East River in the line of 42d St., New York, which is intended to bring electric cars from Long Is. to a point under the Grand Central Station and the Rapid Transit Subway Station. 3800 w. Eng Rec—March 3, 1906. No. 75393.

The Reconstruction of the Ossining Tunnel, New York Central R. R. Illustrates and describes the method of carrying out these improvements without in-

terrupting the heavy traffic of freight and express trains. 2500 w. Eng Rec—March 3, 1906. No. 75392.

The Scranton Tunnel of the Lackawanna and Wyoming Valley Railroad. George B. Francis and W. F. Dennis. Illustrates and describes the construction of this tunnel which contains many interesting engineering features. 7000 w. Pro Am Soc. of Civ. Engrs—March, 1906. No. 75833 E.

Waterproofing Concrete.

Experiences in Water-Proofing Concrete, U. S. Fortification Work. Abstract from Annual Report from 1905 of the Chief of Engineers describing methods used. Ills. 1600 w. Eng News—March 15, 1906. No. 75532.

MATERIALS OF CONSTRUCTION.

Brick.

The Manufacture of Brick from Shale. Illustrated detailed description of a plant at Galesburg, Ill. 2700 w. Eng. Rec—March 17, 1906. No. 75573.

Cement.

Cement Burning. W. H. Hess. Discusses the relation of volume weight of raw cement material to the output of a rotary kiln. 1500 w. Cement Age—March, 1906. No. 75466.

Cement, Mortar and Concrete. Their Preparation and Use for Farm Purposes. Philip L. Wormley, Jr. Reprint from Bul. No. 235, issued by the Dept. of Agriculture. Describes a proper method of mixing concrete, and some points in construction which are of particular interest to farmers. 3500 w. Sci Am Sup—March 10, 1906. Serial, 1st part. No. 75433.

Manufacture of Hydraulic Cements. L. L. Stone. Read before the Univ. of Michigan Engng. Soc. A description of the processes of manufacture. 3000 w. Sci Am Sup—March 10, 1906. No. 75432.

Report of a Test on a Portland Cement Plant. E. C. Soper, Jr. Briefly refers to the history, growth and extent of this industry, describing a typical plant, comparing processes, and reporting tests. Discussion. 7500 w. Jour W Soc of Engrs—Feb., 1906. No. 75418 D.

Concrete Blocks.

The Ideal Concrete Block made Practical. Louis H. Gibson. Outlines the factors to be aimed at in the making of concrete blocks, discussing the principles and suggesting methods. 2800 w. Munic Engng. March, 1906. No. 75339 C.

Marble.

Marble Cutting for the New York Public Library Building. Describes the shop and equipment where this work is carried on. 2000 w. Eng Rec—March 3, 1906. No. 75389.

Marble Working in the Apuan Alps (Italy). Sig. Ernesto Oreglia. Abstracted from *Rassegna Mineraria.* Illustrates and describes the sawing of marble into blocks and the machines used, with other methods and appliances. 4200 w. Quarry—March, 1906. No. 75492 A.

Stucco.

The Manufacture of Plaster of Paris or Stucco. C. O. Bartlett. Describes the method of manufacture, and gives the machinery required. 600 w. Min Rept—March 1, 1906. No. 75349.

Timber.

The Shirley Plant of the Columbia Creosoting Company. Illustrated description of this plant in Indiana which is notable for its advanced ideas in timber preserving practice. 2000 w. R R Gaz—Vol. XL., No. 11. No. 75552.

The Santa Fe's Modern Timber Treating Plant at Somerville, G. B. Shipley. Illustrated detailed description of a plant in Texas to be operated on the Rueping patented creosoting process. 4800 w. Ry Age—March 23, 1906. No. 75814.

MEASUREMENT.

Curves.

The Plotting and Rectification of Curves Applied to the Quadrature and Determination of the Centre of Gravity of Circular Arcs (Die Bogenstreckung und ie Streckenbiegung angewendet zur Geviertung und zur Bestimmung des Schwerpunktes von Kreisteilen). Eduard Linsel. Deriving a number of convenient geometrical constructions for the rectification of curves. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 23, 1906. No. 75733 D.

Metrophotography.

The Reconstruction of Architectural Monuments from Photographs (Sur le Relève des Monuments d'Architecture d'Après leurs Photographies). M. Laussedat. A discussion of the method of combining a number of photographs from various points to form an accurate record of actual dimensions and position. 3000 w. Comptes Rendus—Feb. 19, 1906. No. 75721 D.

Surveying.

Tide Levels and Datum Planes on the Pacific Coast of Canada. W. Bell Dawson. Gives results with regard to datum planes and bench-marks as far as determined. 8800 w. Can Soc of Civ Engrs—Jan., 1906. No. 75616 D.

Tide Indicators.

Tide Level Indicators with Pneumatic Transmission (Indicateurs de Hauteur d'Eau à Courant d'Air Continu). MM. Vidal & Kauffmann. The pencil of a

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recorder is moved by the varying degree of Compression of air in a closed vessel according to the variations in head of water. 3000 w. Ann d Ponts et Chaussées—2 Trimestre, 1905. No. 75772 E + F.

Water Meters.

Resolutions of the Philadelphia City Council against Water Meters. A copy of the resolutions with brief editorial comment. 1500 w. Eng News—March 22, 1906. No. 75652.

MUNICIPAL.

Dust.

The Oiling of Roads (Gondronnages des Routes). M. Guillet. An account of the results effected by the use of oil to prevent dust on roads in the departments of Seine and Marne, from 1903 to 1905. 4000 w. Ann des Ponts et Chaussées—4 Trimestre, 1905. No. 75781 E + F.

Garbage.

A Notable Report on Garbage and Refuse Collection and Disposal at Columbus, O. Reviews the report and detailed estimates submitted and approved by experts, for a plant for the collection and disposal of garbage and rubbish, and the cost of maintaining and operating it. 3300 w. Eng News—March 15, 1906. No. 75533.

Municipal Ownership.

See Industrial Economy.

Sewage.

Sewage Purification and Refuse Incineration Plant, Marion, Ohio. George H. Pierson. Illustrates and describes the plant and method of operation. 4500 w. Eng Rec—March 17, 1906. No. 75569.

Sewers.

The Construction of the Tunnel Line Sewer at Syracuse, N. Y. Profile, plan and illustration, with description of work. 2200 w. Eng Rec—March 3, 1906. No. 75410.

The New Hamburg Main Sewer. Illustrates and describes interesting work in the extension of the Hamburg sewer system. 2200 w. Engr, Lond—March 9, 1906. No. 75603 A.

The Sewerage System of Centerville, Iowa. Notes on the design, construction and cost of a system to meet rather difficult topographical conditions, as described in a paper by Arthur J. Cox, before the Iowa Engng Soc. Ills. 2700 w. Eng Rce—March 24, 1906. No. 75687.

Street Traffic.

London Traffic. Captain G. S. C. Swinton. Discusses mainly the ordinary traffic of the streets and means of improving it. General Discussion. 14000 w. Jour Soc of Arts—March 2, 1906. No. 75491 A.

WATER SUPPLY.

Athens.

Ancient Water Supply of Athens, Greece. Describing parts of a modern waterworks which formed a part of a supply system dating back to the sixth century before the Christian era. 1000 w. Ills. Engr, Lond—March 2, 1906. No. 75511 A.

Conduits.

Cement Conduit at Cambridge, Mass. A 63-inch concrete conduit, 11,500 feet long, built in place, using steel forms and centres. The capacity, running full, is estimated at 30,000,000 per day. 1400 w. Fire and Water—March 3, 1906. No. 75344.

Toronto's Experience with Conduits. C. L. Fellowes. With a description of methods adopted in laying the 6-foot steel conduit. 2500 w. Can Soc of Civ Engrs—Jan., 1906. No. 75617 D.

Dams.

The Belle Fourche Dam, Belle Fourche Project, South Dakota. Raymond F. Walter. One of the largest earthen dams in the United States, now being built, is illustrated and described. 2500 w. Eng Rec—March 3, 1906. No. 75408.

The Changes at the New Croton Dam. Continued discussion of paper on this subject, by Charles S. Gowen. 8500 w. Pro Am Soc of Civ Engrs—March, 1906. No. 75834 E.

The Construction of the Trap Falls Dam, Bridgeport, Conn. Illustrated detailed description of the work. 1800 w. Eng Rec—March 24, 1906. No. 75683.

The Reinforcement of the Grosbois Dam (Consolidation du Barrage de Grosbois). M. Galliot. Describing the manner in which a second dam, with intermediate auxiliary reservoir was constructed to relieve the stresses on an older structure. 5000 w. 1 plate. Ann des Ponts et Chaussées—3 Trimestre, 1905. No. 75776 E + F.

Paris.

The Water Supply from the Loing and the Lunain (Derivation des Sources du Loing et du Lunain). MM. Bechmann & Babinet. A very complete description of the aqueducts, connections and general works of the latest addition to the water supply system of Paris; giving a flow of 50,000 cubic metres per day. 30,000 w. 11 plates. Ann des Ponts et Chaussées—3 Timestre—1905. No. 75774 E+F.

Potability.

The Relation of Sedimentation and Acid Mine Wastes to the Potability of the Lower Monongahela River. S. J. Lewis. Does not consider the sedimentation adequate for the removal of impurities. Also discusses the germicidal effect

of acid mines wastes on pathogenic germs. 3000 w. Eng News—March 15, 1906. No. 75529.

Pumping.

Electric Pumping at Schenectady, N. Y. G. S. Hook. An illustrated description of this plant, now in continuous operation. 1600 w. Jour N Eng W-Wks Assn—March, 1906. No. 75567 F.

Purification.

Experiments with Copper-Iron Sulphate for Water Purification at Marietta, Ohio. Describes the water-works and the filtration, sedimentation and purification plants. The supply is drawn from the Ohio River. 3000 w. Eng Rec—March 24, 1906. No. 75684.

Regulation.

The Automatic Regulation of Flow of Water Plugs and Faucets (La Limitation Automatique du Debit dans les Bornes-Fontaines et Robinets). P. A. Bergès. A description of the various devices for public water supply so arranged as to prevent waste and limit the flow to the actual requirements. Series, Part I. Génie Civil—Feb. 17, 1906. No. 75712 D.

Regulators.

Water Pressure Regulators. A. O. Doane. Brief illustrated descriptions of various makes of regulators for equalizing the pressure in different parts of a distributing system. General discussion 5000 w. Jour N Eng W-Wks Assn—March, 1906. No. 75564 F.

Reservoirs.

A Reinforced Concrete Reservoir at Bloomington, Ill. The method of construction is illustrated and described. 3500 w. Eng Rec—March 3, 1906. No. 75401.

Construction Work on the Charles River Dam and Basin at Boston, Mass. J. Albert Holmes. Illustrates and describes bridge work, the coffer dams, and the Boston marginal sewer. 3500 w. Eng News—March 1, 1906. No. 75306.

The Construction of the Charles River Dam and Basin at Boston. John N. Ferguson. The completion of a temporary highway bridge and approaches, completion of the Boston coffer dam, dredging and pile driving, etc., are illustrated and described. 4500 w. Eng Rec—March 3, 1906. No. 75406.

The Hagerstown Reservoir. J. W. Ledoux. Explains the conditions to be met, and illustrates and describes the storage reservoir finally built. 1600 w. Eng Rec—March 3, 1906. No. 75386.

Siphons.

Experimental Results with Siphon Connections (Ueber Erfahrungen mit Heberleitungen). H. Metzger. A description of the water supply of the city of Bromberg, in Prussia, the water being taken from a number of wells through mains forming several siphons to the pumping station. 5000 w. Gesundheits-Ingenieur—March 10, 1906. No. 75754. D.

Stray Currents.

Electrolysis. A topical discussion with illustrations of the corrosion of pipes by stray electric currents. 6000 w. Jour N Eng W. Wks Assn—March, 1906. No. 75565 F.

Typhoid.

On the Present Relative Responsibility of Public Water Supplies and Other Factors for the Causation of Typhoid Fever. W. T. Sedgwick and C. E. A. Winslow. A discussion of the cause of this disease and the necessary steps to overcome it. The remedy is absolute and universal cleanliness. General discussion. 13000 w. Jour N Eng W. Wks Assn—March, 1906. No. 75566 F.

Water Meters.

See Civil Engineering, Measurement.

Wells.

Strainers for Driven Wells. Dabney H. Maury. Considers driven wells, and the fine and coarse strainers, reviewing the advances in strainer construction. Eng News—March 8, 1906. No. 75436.

WATERWAYS AND HARBORS.

Breakwaters.

A Curious Engineering Analogy in Connection with the Design of the Cleveland Breakwater. Gives report and drawing of a design made in 1877 showing its similarity to types recently built at Buffalo and Cleveland. 1200 w. Eng News—March 15, 1906. No. 75530.

The Sandy Bay Breakwater, National Harbor of Refuge, Cape Ann, Mass. Describes a breakwater which will rank as the most extensive structure of its kind in the United States, so far as depth of water, size and cost are concerned. Ills. 3000 w. Eng News—March 8, 1906. No. 75435.

Canal Lifts.

Helicoidal Canal Lift (Ascenseur pour Bateaux, à Mouvement Hélicoidal). Ch. Dantin. A description of the Oelhafen-Löhle system for raising canal boas from a lower to a higher level. 1500 w. Génie Civil—Feb. 17, 1906. No. 75713 D

Lift Tanks on Rollers Ueber Trogschleusen auf Walzen). Fr. Jebens. Describing an improved form of roller track bearings for tanks to be used on inclined plains for canal lifts. 2000 w. Glasers Annalen—March 1, 1906. No. 75723 D.

Trent-Valley Canal Hydraulic Lift-Lock. J. J. Bell. Information and illustrated detailed description of the hydraulic lift-lock at Peterborough, On-

tario. 3500 w. Engng—March 16, 1906. No. 75805 A.

Embankments.

The Feuerlöscher System of Concrete Cylinder Construction (Die Betonsenkwalze nach der Bauweise Feuerlöscher). Fritz Hromatka. Describing a method of moulding concrete into cylindrical masses for use in submerged river-embankments construction. 1500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 17, 1906. No. 75763 D.

Euphrates.

Plan for the Regulation of the Euphrates (Projet de Régularisation de l'Euphrate) F. Chochod. A description of the Hindieh canal and the plans for a barrage for the distribution of the waters for the Euphrates near Hilleh. 1500 w. Génie Civil—March 10, 1906. No. 75719 D.

Excavation.

Excavation of the West Neebish Channel, near Sault Ste. Marie. Work for the improvement of this channel of the St. Mary's River to increase the capacity of the connection between Lake Huron and Lake Superior is illustrated and described. 2400 w. Eng Rec—March 3, 1906. No. 75413.

India.

The Navigable Waterways of India. Robert Burton Buckley. Information, with maps, of the artificial and natural waterways of India, and matters relating to them. General discussion. 12500 w. Jour Soc of Arts—March 2, 1906. No. 75,490 A.

Jamaica, W. I.

Works for the control of the Wag Water River. J. Mark Fletcher. Describes the conditions existing in many rivers of the island of Jamaica, and the controlling works for the river named. Ills. 1000 w. Eng Rec—March 3, 1906. No. 75414.

Lighthouse.

The Diamond Shoals Lighthouse. Illustrated description of a proposed structure off Cape Hatteras. Steel and concrete will be used in the construction. 2000 w. Sci Am—March 24, 1906. No. 75635.

Panama.

A Proposed Plan for Excavating the Culebra Cut. Presents a plan worked out by Mr. John F. Wallace for the sequence of operations where the elevation is greatest and the largest volume of material to be removed. 2000 w. Eng News—March 1, 1906. No. 75303.

A Trip Through the Panama Canal in 1915. An illustrated description of the canal that is recommended with a presentation of the reasons that led the Commission to decide in favor of a canal with locks and high-level lakes. Editorials and article on sanitation of the canal zone included. 6000 w. Sci Am—March 10, 1906. No. 75430.

Preparing the Isthmus for Canal Construction Work. Fullerton L. Walds. An illustrated description of the conduct of sanitary work on the Isthmus, showing the extent of the measures which have been initiated, and the manner in which they are being carried out. 2500 w. Engineering Magazine—April, 1906. No. 75785 B.

Questions of Safety in a Lock Canal at Panama. Extracts from the Minority Report of the Board of Consulting Engineers for the Panama Canal. 3800 w. Eng Rec—March 17, 1906. No. 75570.

Shall the Panama Canal Be built by Contract? Editorial discussion of this subject, quoting from expressed views of Mr. J. F. Wallace. 3000 w. Eng News—March 15, 1906. No. 75531.

Some Concrete Work in Panama. Howard Egleston. The building of a sea-wall at Borcas del Toro is illustrated and described. 1200 w. Eng Rec—March 3, 1906. No. 75,396.

Some Phases of the Panama Problem. John F. Wallace. Abstract of an address delivered before the Illinois Manufacturers' Assn. Remarks on the construction of the canal, the Téhuantepec railroad, the Panama railroad and the rates. 3000 w. Ry Age—March 9, 1906 No. 75473.

Testimony of Mr. John F. Wallace before the Senate Committee on Interoceanic Canals A condensed abstract of such features of the testimony as are of interest to engineers. 12500 w. Eng News—March 1, 1906. No. 75304.

The Adopted Plan for the Panama Canal. Editorial discussion favorable to a lock canal. 2700 w. Eng News—March 1, 1906. No. 75305.

The Gatun Dam of the Panama Lock Canal Project. Extracts from the Minority Report of the Board of Consulting Engineers for the Panama Canal. Describes the proposed dam, presenting reasons for the choice of this site and information concerning the construction and cost. 4500 w. Eng Rec—March 10, 1906. No. 75477.

The Panama Canal. A. G. Menocal. Submits, for discussion, a modification of the canal route recommended by the Isthmian Canal Commission of 1899-1901 for a lock canal, by which the River Chagres may be kept under absolute control. 4 plates. 2200 w. Pro Am Soc of Civ Engrs—Feb. 1906. No. 75340 E.

The Panama Railroad and the Canal. Fullerton L. Waldo. An illustrated article describing the improvements made in the Panama Railroad and the work expected of it. 800 w. R R Gaz—Vol. XL., No. 9. No. 75316.

We supply copies of these articles. See page 319.

ELECTRICAL ENGINEERING

COMMUNICATION.

Multiple Telegraphy.

The Application of the Hughes System to Multiplex Telegraphy (Ein System für Wechselzeitige Mehrfach telegraphic mittels Hughes-Apparaten). Karl Hansel. With details of the wiring, relay connections and synchronizing, to adapt the Hughes printing telegraph to duplex and multiplex service. Two articles. 5000 w. Elektrotech u Moschinenbau—March 4, 11, 1906. No. 75748 each D.

Telephony.

The Telephone System of the Future—The Semi-Automatic. Le Roy W Stanton. Outlines this system, presenting its advantages. 1200 w. Elec Rev, N. Y.—March 10, 1906. No. 75448.

Telharmony.

Electrical Music. Describes a system Proposed by Dr. Thaddeus Cahill for generating music at a central station and distributing it by means of wires, any distance, as loud as though the orchestra were on the spot. It is produced entirely by electrical apparatus. Ills. 2800 w. Sci Am—March 31, 1906. No. 75825.

The Generating and Distributing of Music by Means of Alternators. Illustrates and describes the electric music generating system of Dr. Thaddeus Cahill, which enables music to be heard, loud enough to fill the largest auditorium, at places many miles distant. 2000 w. Elec Wld—March 10, 1906. No. 75483.

DISTRIBUTION.

Insulation.

Paper CVersus Rubber Insulation for Electric Cables. W. I. Tamlyn. Discusses the cost, life, and electrical properties of the two kinds of insulation. 1600 w. Eng News—March 15, 1906. No. 75526.

Oil-Switch.

The Ferrati New Three-Phase Remote-Control Oil-Switch. Describes the latest development of the oil breaking system. 1200 w. Sci Am Sup—March 31, 1906. No. 75832.

Safety Devices.

Circuit Breakers Newton Harrison. Explains the function of the breaker, and gives a classification with respect to the direction and amount of current, and illustrates and describes types. 5000 w. Cent Sta—March, 1906. No. 75467.

Fuses. Dean Harvey. An illustrated article discussing their characteristics, standardization, and types. 2500 w. Elec Jour—March, 1906. No. 75629.

Notes on the American System of Fuse Standardization. Alfred Schwartz. Showing that both on the Continent and in America the fuse has received more attention than in England. 1800 w. Elec Rev, Lond—March 2, 1906. No. 75501 A.

The Operation of Circuit Breakers and Fuses. Prof. E. W. Marchant, and F. A. Lawson. A report of experiments made to determine exactly what size of fuse it was possible to have in series with a given circuit breaker to put it in action without blowing the fuse. 1200 w. Elect'n, Lond—March 2, 1906. No. 75503 A.

Substations.

See Street and Electric Railways.

Three-Phase.

Simple Diagrams for Three-Phase Power Calculations. Alfred Still. Explains by the use of vector diagrams what is to be understood by the real and apparent power of the three-phase circuit under various conditions as regards load. 1500 w. Power—March, 1906. No. 75384 C.

Three-Wire.

Balancers. Budd Frankenfield. A comparison of the direct-current motor generator and the alternating-current auto transformer. The comparison is limited to symmetrical three-wire systems of distribution or systems for which the voltages between either main and the neutral are approximately equal. 1500 w. Elec Rev, N. Y.—March 10, 1906. No. 75446.

Wiring.

Conduit Wiring for Electric Installations. Abstract of a paper read before the Elec. Contractors' Assn. Reviews the practice of electric wiring, discussing the various conduits used and methods of installing. 3000 w. Electn, Lond—March 2, 1906. No. 75504 A.

Electrical Conduit Work in Fireproof Buildings. Thomas W. Poppe. Illustrated discussion of the best methods. 1000 w. Elec Wld—March 3, 1900. No. 75359.

Residence Wiring. Louis J. Auerbacher. Gives sample specification for a four-story and basement house having wooden floors and partitions, with analysis, and detailed description of apparatus. 4500 w. Elec Wld—March 3, 1906. No. 75358.

The Slide Rule as a Substitute for the

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Wire Table. Carl P. Nachod. Outlines methods for resistance calculations which are extremely rapid, yet accurate. 900 w. Elec Wld—March 3, 1906. No. 75357.

ELECTRO-CHEMISTRY.

Electric Smelting.

See Mining and Metallurgy, Iron and Steel.

Electro-Metallurgy.

Electro-Technical Industries, Reviews the achievements in the electric-metallurgical field during the last half-dozen years. 1800 w. Sci Am Sup—March 31, 1906. No. 75831.

Nitrogen.

Electro-chemistry and the Problem of the Fixation of Atmospheric Nitrogen (La Fixation de l'Azote et l'Electrochimie). Philippe A. Guye. A study of the methods of fixation of atmospheric nitrogen showing the problem to be one of electro-chemistry, and dependent upon the low cost of electrical energy. 4000 w. Rev. Gen. d'Sciences. Jan. 15, 1906. No. 75768 D.

The Artificial Production of Nitrates from the Atmosphere. Gives views of the factory in Notodden, Norway, where nitrate lime is being manufactured by the Birkeland and Eyde process, with information concerning the work. 1300 w. Engr, Lond—March 16, 1906. No. 75801 A.

The Production of Nitric Acid by Explosive Combustion (Darstellung von Salpetersäure mittels Explosiber Verbrennung). Hr. Häuser. Describing a scheme for producing nitric acid by the explosive combustion of nitrogen and oxygen by the electric spark in the cylinder of a gas engine; thus utilizing the power of the explosion. 3500 w. Zeitschr d Ver Deutschr Ing—Feb. 24, 1906. No. 75707 D.

The Utilization of Atmospheric Nitrogen (Utilization de l'Azote Atmospherique). E. Lemaire. A review of the electrical methods for the fixation of atmospheric nitrogen. Serial, Part I. 3000 w. Génie Civil—March 10, 1906. No. 75718 D.

ELECTRO-PHYSICS.

Analogies.

Analogies Between Light and Electric Waves.—Braun's Experiments. Prof. B. Dessau, in *Umschau*. Reviews some experimental studies of the electro-magnetic theory of light, especially the experiments of Braun. 1200 w. Sci Am Sup—March 3, 1906. No. 75322.

Currents.

Idle Currents. M. B. Field. Abstract of paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Considers the losses from idle currents in main conducting circuits. 2700 w. Elec Engr, Lond—Feb. 23, 1906. No. 75367 A.

Discharge.

Recent Investigations Upon the Mechanism of the Disruptive Discharge (Recherches, Recente sur le Mécanisme de la Décharge Disruptive). M. Langevin An examination of disruptive electrical discharges in the light of the electron theory, showing their bearing upon the study of the nature of electricity. 7000 w. Bull Soc Int des Electriciens—Feb., 1906. No. 75760 G.

Hysteresis

Magnetic Hysteresis (L'Hysteresis Magnetique). P. Duhem. A study of the phenomena of magnetization in fields of varying intensity, and a discussion of the consequent effects of hysteresis. Two articles. 7500 w. Rev Gen d Sciences—Jan. 15, 30, 1906. No. 75767 each D.

Lightning.

Lightning and the Electricity of the Air. Alexander G. McAdie. Reviews the investigations of Franklin and his co-laborers in this field, and of later investigations to the present time, discussing the protection from lightning and related subjects. Ills. 11700 w. Jour of Elec—March, 1906. No. 75471 C.

Magnet Coils.

Graphical Determination of the Dimensions of Magnet Coils. C. Kinzbrunner. Gives curves used for the determination of the dimensions, explaining how they are obtained. 900 w. Elec Engr, Lond—March 2, 1906. No. 75498 A.

Radio-Activity.

Cathode Rays in a Magnetic Field (Les Rayons Cathodique dans le Champ Magnetique). P. Villard. A study of the behaviour of the corpuscles in magnetic fields of various intensities and distribution. 7000 w. 4 Plates. Bull Soc Int des Electriciens—Feb. 1906. No. 75759 G.

Self Induction.

Self-Induction Effects in Steel Rails. Ernest Wilson. An account of experimental investigations, with results. 2800 w. Electn, Lond—Feb. 23, 1906. No. 75365 A.

Sparks.

The Heating Effect of the Electric Spark. Henry A. Perkins. A report of research work, with conclusions. Also editorial. 3000 w. Elec Wld—March 24, 1906. No. 75691.

GENERATING STATIONS.

Alternators.

Johannesburg Alternators. Illustrated description of some large alternate-current dynamos of the two-phase type, for

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coupling with gas-engines which run at 100 r. p. m. Reports their trial. 1000 w. Elec Engr, Lond—March 16, 1906. No. 75669 A.

Armatures.

The Distribution of Magnetic Induction and Hysteresis Loss in Armatures. Dr. W. M. Thornton. Read before the Newcastle Loc. Sec. of the Inst. of Elec. Engrs. A study of magnetic distribution, analysing the results. Ills. 1400 w. Elec Engr, Lond—March 9, 1906. Serial, 1st Part. No. 75592 A.

Auxiliaries.

The Betterment of Power-Station Economy by Electric Auxiliaries. Arthur S. Mann. Showing the importance of balancing the advantages of electrically operated auxiliaries against the value of the exhaust steam for heating purposes. 2500 w. Engineering Magazine—April, 1906. No. 75788 B.

Central Stations.

Central Station Power. E. F. Espenschied, Jr. On the use of power in the industries and so increasing the revenue producing hours, the motors required, etc. Discussion. 4000 w. Pro. Engrs' Soc of W Penn—March, 1906. No. 75-621 D.

Dynamos.

A study in the Design of a 500-K. W. Continuous-Current Generator. Dr. Max Breslauer. Determines a common basis for the comparison of the different formulae generally used as a criterion for the sparking conditions, and discusses the figures and dimensions of this special machine. Ills. 3300 w. Electn, Lond—March 9, 1906. Serial, 1st part. No. 75593 A.

The Conversion of Energy in Dynamo-Machines (Ueber die Umwandlung der Energie in Dynamomaschinen). Karl Pichelmayer. A general study of the transformation of energy and the theories of leading physicists, with illustrations taken principally of electrical machinery 4000 w. Elektrotech u Maschnnebau—Feb. 25, 1906. No. 75746 D.

Hartford.

The Dutch Point Station of the Hartford Electric Light Company. Illustrated description of a new steam-turbine-driven station. 2000 w. Elec Wld—March 3, 1906. No. 75353.

Houston, Tex.

The Houston, Tex., Lighting and Power Company. An illustrated article giving information of the recently improved plant of this company and its equipment and operation. 3000 w. Elec Wld—March 24, 1906. No. 75690.

Hydro-Electric.

Construction of the Neale Shoals Power Plant on Broad River, S. C. Francis J. Sellew. Description, with illustrations, of the engineering details and methods of construction employed on a recently completed plant. 8000 w. Eng Rec—March 3, 1906. No. 75397.

Hydro-Electric Enterprise in Canada. Paul N. Nunn. Illustrates and describes the development of the Ontario Power Company, at Niagara Falls. Presented at convention of the A. I. E. E. 4500 w. Can Engr—March, 1906. No. 75482.

Notes and Designs of Hydro-Electric Power Stations. (With Reference to the Influence of Load Factor.) David B. Rushmore. Discussion with diagrams of various features, with particular reference to the economic side of such plants and electric transmission of power. 4000 w. Am Inst of Elec Engrs—March 23, 1906. No. 75658 D.

Power Development at St. Croix Falls for the Minneapolis General Electric Company. Adolph Edsten. General plan and illustrations with description. 2300 w. Eng Rec—March 3, 1906. No. 75405.

The Feistritzhammer Electric Station at Krieglach. (Elektrizitätswerk Feistritzhammer in Krieglach.) G. Witz. An illustrated description of a plant deriving 350 h. p. from the river Mürz, at Krieglach in Styria. 3000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Feb. 23, 1906. No. 75732 D.

The Relation of Load-Factor to the Evaluation of Hydroelectric Plants. S B. Storer. Discussion and diagrams showing the effect of load factor upon steam and water driven electric plants respectively, and a conclusion that with constant flow of water, the earning power, and hence the value of the hydro-electric plant is proportional to the load factor. 1000 w. Am Inst of Elec Engrs—March 23, 1906. No. 75657 D.

Two Interesting Tyrol Hydroelectric Plants. Franz Koester. Brief illustrated descriptions of the plants at "Malserheide," near Glurns, and "Reinzwerke" of the City of Brixen. 2000 w. Elec Rev, N. Y.—March 24, 1906. No. 75665.

Utilization of the Waters of Lake Titicaca, Peru. Emile Guarini. Proposes a rather unusual plan for furnishing Peru with cheap power and afterwards utilizing the water for irrigation. 1300 w. Elec Rec, N. Y.—March 24, 1906. No. 75664.

Isolated Plant.

The Design of an Isolated Power and Lighting Plant. Putnam A. Bates. From a paper read at meeting of the Elec Engng Soc of Columbia Univ. Describes a plant installed to serve several machine shops. 2400 w. Eng Rec—March 10, 1906. No. 75480.

We supply copies of these articles. See page 319.

Management.

Power Plant Operation and Management. H. Schreiber. Discusses points of importance in securing economy and reliability. 2200 w. Jour of Elec—March, 1906. Serial, 1st part. No. 75469 C.

Motor Generators.

Some Features Affecting the Parallel Operation of Synchronous Motor Generator Sets. J. B. Taylor. Details of construction, connections, and method of operation to insure a desired diversion of load among such units, consisting of synchronous motors directly connected to alternating current generators. Diagrams and Ills. 4500 w. Am Inst of Elec Engrs—March 23, 1906. No. 75656 D.

N. Y. Central.

The Steam-Electric Power Stations of the New York Central Railroad. Illustrated detailed description of the two power stations which are to supply electric current for the operation of suburban trains. 3500 w. Power—March, 1906. No. 75381 C.

Station Design.

The Design of a Small Electric Power Station. James F. Hobart. The first of a series of articles dealing with the design, construction, selection and installation of machinery, operation of the plants, etc. 2500 w. Elec Wld—March 3, 1906. Serial, 1st part. No. 75356.

Switchboards.

Development in Design and Construction of Switchboards and Cable Runs for Large Direct Current Installations. Edward Schildhauer. An illustrated paper showing the development in switchboard design and construction of cable runs. 4500 w. Wis Engr—Feb., 1906. No. 75310 D.

Notes on Heavy Electric Switchgear. J. Whitcher. Abstract of a paper read before the Rugby Engng. Soc. A plea for simplicity in design, construction and operation, discussing details. 6000 w. Mech Engr—March 3, 1906. No. 75497 A.

LIGHTING.

Arcs.

Municipal Arc Lighting from Steam Turbine Power. Illustrates and describes the city plant at Columbus, Ohio. 2000 w. Elec Rev, N. Y.—March 10, 1906. No. 75447.

Carbons.

The Wilton Carbon Factory. An explanation of why this industry in England is threatened, and an illustrated description of the manufacture of arc lamp carbons as seen at Wilton. 2200 W. Elec Engr, Lond—March 16, 1906. No. 75668 A.

Frequency.

Electric Lighting with Various Frequencies (L'Eclairage Electrique aux Diverses Frequences). P. Lauriol. A study of the effects of alternating currents of various frequencies upon the flickering of incandescent lamps; showing that the choice of frequency should depend upon the nature of the service. 6000 w. Bull Soc Int des Electriciens—Feb., 1906. No. 75758 G.

Globes.

The Effect of Acid Frosting and Enclosing Globes Upon the Life of Incandescent Electric Lamps. J. R. Cravath and V. R. Lansingh. A report of interesting tests, with a study of the results. 1500 w. Elec Wld—March 17, 1906. No. 75590.

Interiors.

The Lighting of Miscellaneous Rooms in Residences. J. R. Cravath and V. R. Lansingh. An illustrated article intended to supplement two previous articles on residence lighting. Considers large parlors, kitchens, the porch, bath room, basement and hall. 2000 w. Elec. Wld.—March 3, 1906. No. 75354.

Photometer.

See Electrical Engng. Measurement.

Waste.

Waste in Incandescent Electric Lighting and Some Suggested Remedies. Abstract of the discussion in connection with Mr. George Wilkinson's paper on the above subject. 6000 w. Elect'n, Lond—March 16, 1906. No. 75680 A.

MEASUREMENT.

Bolometer.

Note on the Use of the Bolometer as a Detector of Electric Waves. C. Tissot. Describes investigations. 2000 w. Elec Engr, Lond—March 2, 1906. No. 75499 A.

Electrical Units.

International Conference on Electrical Units. Gives the final decisions of the conference held at Charlottenberg (Berlin), Germany, in October, 1905. 3500 w. Elec Wld—March 24, 1906. No. 75694.

Ohm.

Mercurial Standards of Electrical Resistance (Les Etalons Mercuriel de Résistance Electrique). C. E. Guillaume. A discussion of the paper of M. Girousse, showing the causes of variations in the resistance of a column of mercury in a glass tube. 5000 w. Bull Soc Int des Electriciens—Jan., 1906. No. 75757 G.

Standards for the Legal Ohm (Les Etalons de l'Ohm Légal). G. Girousse. An account of the work of the laboratory of the Superior School of Posts and Telegraphs, with especial reference to the production, and comparison of mercury standards for the ohm. 3500 w. Bull de la Soc Int des Electriciens—Dec., 1905. No. 75756 G.

We supply copies of these articles. See page 319.

Oscilloscope.

The Oscilloscope. Dr. Lewis Jones. Calls attention to Ruhmer's ingenious oscilloscope, which makes a graph of the discharge in high potential circuits by mapping the length of cathode rendered luminous by the discharge. Ills. 700 w. Elec'n, Lond—March 16, 1906. No. 75679 A.

Phasemeters.

Phasemeters and Their Calibration. W. E. Sumpner. Showing the method of calibrating the instrument by using direct currents of known values, and thus obtaining deflections corresponding to definite phase angles. 3500 w. Elect'n, Lond—Feb. 23, 1906. No. 75366 A.

Photometer.

The Globe Photometer. An illustrated account of this apparatus, the function of which is to give by one observation the value of the whole amount of light emitted by any source, such as an arc lamp, or an incandescent lamp. Information from a paper by Dr. Bloch. 1700 w. Elec Rev, Lond—March 16, 1906. No. 75670 A.

Potentiometers.

Deflection Potentiometers. H. B. Brooks. Abstract of a paper to be published in the *Bulletin* of the U. S. Bureau of Standards. Describes the principles upon which a deflection potentiometer has recently been constructed and put into service for voltage measurements in photometric work. Ills. 1500 w. Elec Wld —March 17, 1906. No. 75588.

Sparking.

Calculation of Dynamo Sparking Constants. A. Press. Presents empirical formulae apparently not difficult to apply. 1600 w. Elec Wld—March 10, 1906. No. 75485.

MOTORS.

Commutation.

Commutation in Single-Phase Motors at Starting. Marius Latour. A mathematical study of commutation when resistance leads are used. 2000 w. Elec Wld—March 10, 1906. No. 75484.

Induction Motors.

Repulsion Induction Motor. Maurice Milch. Explains the action of this motor, supplementing the explanation with characteristic curves obtained from tests on motors built for commercial purposes. 3000 w. Am Inst of Elec Engrs—Feb., 1906. No. 75343 D.

Iron Losses.

Iron Losses in Single-Phase Commutator Motors. Prof. Dr. F. Niethammer. Describes a simple experiment performed to ascertain in just what manner the iron loss varies with the speed. Diagrams, 700 w. Elec Wld—March 24, 1906. No. 75693.

Single-Phase.

A New Single-Phase Commutator Motor. V. A. Fynn. Illustrated description of a motor that can be built with either shunt or series characteristic. 12700 w. Inst of Elec Engrs—March 8, 1906. No. 75591 D.

Circle Diagram of Compensated Series Single-Phase Motor. E. C. Stone. Outlines the construction of the circle diagram. Editorial comment, 2500 w. Elec Wld—March 24, 1906. No. 75692.

Comparative Investigations of a Collector Motor (Verleichende Untersuchungen an einen Kollektormotor). R. Czepek. Data and results of tests of a seven horse power four-pole single-phase series motor. 3500 w. Elektrotech u Maschinenbau—March 11, 1906. No. 75749 D.

See also Street and Electric Railways.

Speed Control.

A Graphic Method of Showing the Action of Auxiliary Pole Variable-Speed Motors. Norman G. Meade. Diagrams and description. 300 w. Elec Wld—March 17, 1906. No. 75589.

Speed Characteristics and the Control of Electric Motors. Charles F. Scott. Discussing especially the practical methods of speed control of direct-current motors as applied to the driving of machine tools. 5000 w. Engineering Magazine—April, 1906. No. 75787 B.

The Lincoln Variable Speed Motor. Illustrated description of a four-pole shunt motor with the shunt field windings connected in series. 900 w. Ir Age—March, 1906. No. 75300.

Unipolar.

The Unipolar Machine as a Single-Phase Alternating-Current Motor (Die Unipolar Maschine als Einphasen-Wechselstrommotor). Josef Huppert. A brief examination of the operation of the acyclic dynamo, and the applicability of the machine to operation by single-phase currents. 1000 w. Elektrotech u Maschinenbau—March 4, 1906. No. 75747 D.

TRANSMISSION.

Cable Tests.

Tests of an Armored Cable for Three-Phase Current at 27,000 Volts (Essais d'un Cable Armé pour Courant Triphasé à 27,000 Volts). Data and results of tests upon a transmission cable between Entraygues and Toulon, under tensions as high as 90,000 volts, for a working tension of 27,000 volts. 1200 w. Génie Civil—Feb. 17, 1906. No. 75714 D.

Long Distance.

The Electrical Transmission of Power Over Great Distances. S. M. Kintner. Deals principally with the transmission of alternating current. Discussion. 5500 w. Pro Engrs' Soc of W Penn—March, 1906. No. 75622 D.

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INDUSTRIAL ECONOMY

Coal Trade.

Wages and Profits in the British Coal Trade. T. Good. Gives facts and figures tending to prove that the coal miner receives fair wages, and that the profits are small. 1600 w. Cassier's Mag—March, 1906. No. 75608 B.

Education.

The Education of the Commercial Engineer. W. Bardill. Read before the Birmingham Assn. of Mech. Engrs. General remarks on education, with discussion of this special subject as viewed from the English standpoint. 4200 w. Engr, Lond—March 16, 1906. No. 75804 A.

Exposition.

Electricity at. the Liége Exposition (L'Electricite à l'Exposition de Liége). A series of illustrated reviews by various specialists of the various electrical exhibits at the Liége exposition. Serial, Part I. 4000 w. L'Electricièn—Jan. 6, 1906. No. 75765 B.

Finances.

The Finances of Engineering. William D. Marks. A discussion of the salaries paid engineers, and the business methods affecting them. 4500 w. Jour Fr Inst—March, 1906. No. 75559 D.

Geology.

Geology in Relation to Engineering. Stanley C. Bailey. An illustrated article showing the value of a good knowledge of geology to civil and mining engineers and architects; and calling attention to various cases where the knowledge is of use. 3000 w. Engr, Lond—March 16, 1906. Serial, 1st part. No. 75800 A.

Iron Ore.

Estimated Fifty Million Tons Iron Ore This Year. Editorial review of the ore shipments through the Sault canals since 1855, showing the increase, and commenting on the future outlook. 900 w. Min Wld—March 24, 1906. No. 75674.

Labor.

The Unemployed and Trades Unions. David McLaren Morrison. Claims that the number of the unemployed is due to the mistaken policy of the trades unions, and outlines a plan to provide age pensions and for sickness, and suggests following the example of Germany in confining those who will not work and forcing them to earn. 2000 w. Nineteenth Cent—March, 1906. No. 75659 D.

Mining.

Mining Stocks—How to Calculate Their Values. Francis C. Nichols. Gives statements, calculations, and tables aiming to bring together material which may be a guide to the proper understanding of the risks and oportunities in mining ventures. 3500 w. Min Wld—March 17, 1906. Serial, 1st part. No. 75579.

Municipal Ownership.

The Dalrymple Report. The full report of Mr. Dalrymple, of Glasgow, on the Chicago street railway situation. 8400 w. St Ry Jour—March 17, 1906. No. 75578 C.

Profit Sharing.

Profit Sharing as a Peace and Profit Maker. R. M. Downey. Read at meeting of the Nat. Metal Trds. Assn. Explains the plan adopted by the Keystone Driller Company, which is working to the satisfaction of all concerned. 2500 w. Ir Age—March 29, 1906. No. 75824.

Public Ownership.

The Ownership of Public Utilities. Lyman E. Cooley. Briefly discusses the problem in its historical and geographical aspect, giving the writer's conclusions. 3000 w. Jour W Soc of Engrs—Feb., 1906. No. 75417 D.

Specifications.

A Legal Criticism of Government Specifications. Suggestions based on conversations with contractors and a study of the decisions of the Supreme Court and Court of Claims, and experience in cases in those courts. 2000 w. Eng Rec—March 3, 1906. No. 75387.

Steel Corporation.

The United States Steel Corporation's Annual Report. Extracts from the report covering the operations of the fiscal year ended Dec. 31, 1905, showing the largest gross earnings in its history. 4000 w. Ir Age—March 22, 1906. No. 75633.

Wages.

Wages in the Engineering and Shipbuilding Industry in the 19th Century. A. L. Bowley and G. H. Wood. Abstracted from a paper read before the Statistical Society. Gives diagrams showing fluctuations of wages, and information of interest. Steady progress is shown. 3800 w. Ir & Coal Trds Rev—March 9, 1906. No. 75594 A.

Works Management.

The Square Deal in Works Management. O. M. Becker. Mr. Becker's fourth and concluding paper deals with the auxiliary methods of successful labor employers in developing the interest and welfare of their employees. 4000 w. Engineering Magazine—April, 1906. No. 75786 B.

We supply copies of these articles. See page 319.

MARINE AND NAVAL ENGINEERING

Boiler Explosion.

See Mechanical Engineering, Steam Engineering.

Breakdown.

A Marine Generating-Set Breakdown —Cause, Effect, and Repair. Illustrated description of a breakdown of an electric engine, discussing the cause 1500 w. Am Mach—Vol. 29, No. 10. No. 75428.

Electric Power.

Applications of Electricity on War Ships (l'Electricité à Bord des Navires de Guerre). G Maugas. A review of the applications of electricity on shipboard, including lighting, auxiliary motors, communication, etc., as well as the propulsion of submarines. 5000 w. Bull de la Soc Int des Electriciens—Dec., 1905. No. 75755 G.

Ferry House.

Fireproof Ferry Structure of the Lackawanna. Illustrates and describes an interesting method of construction to be used in rebuilding the ferry terminal at West 23d St., New York. The difficulties are explained, and the method of fireproofing. 1800 w. Ry Age—March 23, 1906. No. 75817.

Gas Engines.

See Mechanical Engineering, Combustion Motors.

Launch.

The Fifty-one Foot Cruising Launch Anita. Illustrated description. 800 w. Marine Engng—March, 1906. No. 75331 C.

Lifeboats..

The Government's Gasoline Lifeboats. Illustrated description of the latest design of lifeboat constructed for the United States Life-Saving Service. It is of the self-bailing, self-righting, non-sinkable type, and has a 20-h. p. gasoline engine of the four cylinder, auto-marine type. 1500 w. Sci Am—March 17, 1905. No. 75555.

Motor Boats.

A Serviceable Twin-Screw Motor Boat. Thomas J. Fay. Illustrates and describes the principal features of a new twin-screw boat fitted with two separate power plants. 1200 w. Sci Am—March 3, 1906. No. 75320.

Hydroplane Boats: Latest Type of High-Speed Craft. William M. Meacham. An illustrated article describing the writer's experiments with submerged plates, which lifted the hull of the boat out of the water, thus lessening the resistance. 1600 w. Sci Am—March 3, 1906. No. 75319.

Sixty Miles an Hour on the Water. Ernest Archdeacon. Translated from *La Vie Automobile*. Describes the hydroplane boat constructed by M. le Comte de Lambert, more than two years ago, and comments on the value of the principles of its design. 1100 w. Sci Am—March 3, 1906. No. 75318.

Steel Motor Boat for South America. Illustrated description of a steel hull, kerosene motor-propelled boat, built at Mariner Harbor, N. Y., for service on the Amazon River. 1000 w. Naut Gaz—March 1, 1906. No. 75345.

The "Spider" and the "Sandfly"—Two Shallow Draught Motor Boats. Illustrates and describes boats of very shallow draught; fitted with internal combustion engines. 700 w. Auto Jour—March 10, 1906. No. 75581 A.

Naval Engineers.

British Admiralty Policy and its Consequences. A discussion of the dissensions between the executive and the engineer officers in the British Navy, showing the insufficiency of the present Admiralty policy. 4000 w. Engineering Magazine—April, 1906. No. 75784 B.

The Efficiency of Engineering Personnel in the Navy. W. M. McFarland. A review of the natural consequences of the non-enforcement of the Personnel Law, and a plea for the discontinuance of the official discrimination between the two branches of the service in the United States Navy. 2500 w. Engineering Magazine—April, 1906. No. 75783 B.

Revenue Cutter.

United States Revenue Cutter No. 15. Illustrated detailed description of a steam revenue cutter for service in the waters of Albemarle and Pamlico sounds, on the Carolina coast. 1500 w. Marine Rev—March 1, 1906. No. 75325.

Shipbuilding.

A Survey of Scotch Shipbuilding in 1905. Benjamin Taylor. A review of the striking developments of a very successful year. 2400 w. Marine Engng—March, 1906. No. 75330 C.

The Shipbuilding and Shipping Industries of Germany. J. Ellis Barker. Reviews the development of this industry in Germany, especially in the last thirty years. 6800 w. Contemporary Rev—March, 1906. No. 75568 D.

Shipyards.

See Mechanical Engineering Machine Works and Foundries.

Steamers.

The China Navigation Company's Steamer "Huichow." Illustrates and describes one of six vessels recently built

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for service between China, Australia, the coast and rivers of China. 900 w. Engng—Feb. 23, 1906. No. 75373 A.

The P. & O. Twin-Screw Steamer "Mooltan." A series of illustrations of the latest steamer of this company, with information concerning the progress of the company during the past 35 years. 2300 w. Engng—March 9, 1906. Serial, 1st part. No. 75600 A.

Torpedo Boats.

The Development of the Torpedo-Boat Destroyer. W. J. Harding. Read before the Inst. of Marine Engrs., England. Historical review. Ills. 2500 w. Sci Am Sup—March 24, 1906. Serial, 1st part. No. 75637.

Torpedoes.

The Protection of Ships of War against Mines and Torpedoes (La Protection des Navires de Guerre contre les Mines et les Torpilles). R. Blochmann. A study of the lessons of the Russo-Japanese war; with suggestions as to the improvements in hull design, with reference to submarine protection. 2000 w. Rev Gen d Sciences—Jan. 30, 1906. No. 75769 D.

Transport.

The Military Transport Borussia (Der Truppentransportdanpmfer Borussia). Walter Hildebrandt. A fully illustrated description of the 7,500 ton transport recently completed at Kiel for the Hamburg-America Company. 2000 w. Schiffbau—March 28, 1906. No. 75762 D.

Trials.

Analyses of the Trials of the Ferry-Boat "Scranton." Graduating thesis of A. H. Potbury, E. A. Stevens, Jr., and O. von Voigtlander, with introductory by Col. E. A. Stevens. Description of test, with tables, explanations of methods, etc. 4500 w. Stevens Ind—Jan., 1906. No. 75534 D.

MECHANICAL ENGINEERING

AUTOMOBILES.

Brakes.

Automobile Brakes (Automobilbremsen). R. Lutz. Giving details of the various types of brakes used by the leading builders of automobiles, and their applicability as safety devices. 3500 w. Zeitschr d Ver Deutscher Ing—Feb. 17, 1906. No. 75702 D.

Carbureter.

Packard Automatic Carbureter. Illustrated description of an interesting example of American carbureter practice. The carbureter is fitted with a hot-circulating water jacket. 900 w. Automobile —March 15, 1906. No. 75542.

Clutches.

Hydraulic Clutches — —The Sparks-Boothby Clutch. Illustrated description of this clutch and its action. 1100 w. Auto Jour—March 17, 1906. Serial, 1st part. No. 75689 A.

Crawshay-Williams.

The 16 H. P. Crawshay-Williams Petrol Car. Illustrates and describes a British touring car. 1500 w. Auto Jour —Feb. 24, 1906. No. 75361 A.

Enfield.

The 30 H. P. Enfield Car. Illustrates and describes a recently built all-British car. 1000 w. Autocar—March 17, 1906. No. 75667 A.

Engines.

See Mechanical Engineering, Combustion Motors.

French Practice.

Trend of French Practice in Construction. Rene M. Petard. Gives some conclusions drawn from tendencies observed at the Paris Salon. 2000 w. Automobile —March 29, 1906. No. 75839.

History.

The Forerunners of the Automobile. F. M. Feldhaus. Illustrates and describes devices used as early as 1447, and later. 2000 w. Sci Am Sup—March 31, 1906. No. 75828.

Ignition.

Electric Ignition for Motor Cars. Frank Little. Discusses both low- and high-tension systems and their operation. Ills. 2200 w. Elec Engr, Lond—Feb. 23, 1906. No. 75368 A.

Industrial Vehicles.

Motor Vehicles for Business Work. M. C. Krarup. Discusses the question of economy in using motor vehicles for transportation work, summarizing the matters which should be considered when their adoption is contemplated. 5500 w. Ir Age—March 1, 1906. No. 75299.

Report on the International Exhibition of Industrial Vehicles of August, 1905 (Rapport sur le Concours Internationale de Vehicules Industriels en Aout, 1905). Georges Lumet. A detailed report of the competitive trials of the Automobile Club de France with tables and diagrams of the results. 7000 w. Mem Soc Ing Civ de France—Nov., 1905. No. 75730 G.

Lorry.

A New Steam Lorry. Illustrated description of a 40-h. p. steam lorry and its engine. 900 w. Engr, Lond—March 2. 1906. No. 75513 A.

Lucas.

A Car with a Valveless Motor. Illustrated description of a Lucas Car with its two-cycle engine and its working. 2000 w. Autocar—Feb. 24, 1906. No. 75364 A.

Motor Sleigh.

A Simple and Speedy Motor Sleigh. Brief illustrated description of a machine recently constructed at Springfield, Ohio, said to be capable of making 35 miles an hour on snow and 90 miles an hour on ice. 400 w. Sci Am—March 31, 1906. No. 75826.

Six Wheels.

Vehicles with Six Wheels (Les Voitures à Six Roues). M. Le Gaurian. A description of the compensation suspension system of Capt. Lindecker, for distributing the load upon three axles, especially adapted for heavy vehicles. 4000 w. Ann des Ponts et Chausées—4 Frimestre, 1905. No. 75779 E + F.

Specifications.

Specifications of Material Used in High-Speed Automobile and Motor-Boat Engines. Thomas J. Fay. Gives tabulated specifications of the qualities of materials used, with remarks. 900 w. Sci Am Sup—March 3, 1906. No. 75324.

Steam Wagon.

The Sentinel Steam Wagon. Illustrated detailed description of a vehicle built in Glasgow and its engine. 1600 w. Engr, Lond—March 9, 1906. No. 75607 A.

Steering.

Auto Drive, Steering and Skidding. L. M. Dieterich. A study of steering systems, with diagrams showing forces acting. 2000 w. Automobile—March 15, 1906. No. 75541.

Testing Plant.

See Mechanical Engineering, Measurement.

Trials.

Tyre, Lamp, and Speedometer Trials. An illustrated account of these interesting trials now in progress. The cars are fitted with Collier tyres of different sections, each car carrying one or two speed indicators, and one or more lamps. 1800 w. Auto Jour——March 10, 1906. No. 75582 A.

War Automobiles.

New Armored War Automobiles. Illustrates and describes new types constructed in France and Austria, reporting experiments made at the maneuvering grounds. 1500 w. Sci Am—March 17, 1906. No. 75554.

See also Mechanical Engineering, Combustion Motors.

COMBUSTION MOTORS.

Automobile Engines.

A Defect in the Motor and a Remedy. A. Gordon Ede. A proposition for increasing the power range of the engine by varying the compression. 2300 w. Autocar—March 10, 1906. Serial, 1st part. No. 75597 A.

Petrol Motors. A. Cyril Hutt. Read before the King's College Engng Soc. Considers single-cylinder motors, multi-cylinder engines, water cooling, valve gear, clutches, lubrication, carburetters, ignition, etc. Ills. 5200 w. Autocar—Feb. 10, 17, 24, 1906. 3 parts. No. 75363 each A.

Engines.

Gas, Oil and Petrol Engines. Henry N. Bickerton. Abstract of a paper before the Manchester Assn. of Engrs. Reviews present practice in these engines, and matters relating to their working, economy, etc. Discusses several types. 4000 w. Mech Engr—March 17, 1906. No. 75698 A.

Furnace Gas.

Available Power and Cost of Operation of a Power Station for Waste Gases from a Blast-Furnace Plant. H Freyn. Gives calculations assuming a new blast furnace plant of two 400-ton blast furnaces, situated in the vicinity of a large city with facilities for water supply and handling material. Discussion. 14000 w. Jour W Soc of Engrs—Feb., 1906. No. 75420 D.

Gas Engines.

New Acme High-Speed Vertical Tandem Gas Engine (Burt's Patents). Illustrated description. 1000 w. Mech Engr—March 3, 1906. No. 75496 A.

Rational Methods of Gas-Engine Powering. Sanford A. Moss. Gives general principles and rational formulas for the selection of the speed and cylinder dimensions of a gas engine to develop a given amount of power with a given fuel. Only four-cycle stationary engines are considered. 3000 w. Am Mach—Vol. 29, No. 12. No. 75642.

Some Recent Examples of the Use of Gas and Gasoline Engines in Marine Work. Illustrates and describes engines used in several vessels of diverse types. 3000 w. Eng News—March 22, 1906. No. 75648.

The Action of the Cylinder Walls of Internal-Combustion Motors (Comment s' Exerce l'Action de Paroi dans les Moteurs à Combustion Interne). L. Letombe. A study of the action of the cooling of the cylinder by water circulation, claiming that the efficiency of the engine is unaffected thereby. 4500 w. Mem Soc Ing Civ de France—Nov. 1905. No. 75727 G.

The Prime Mover of the Future. C. E. Sargent. Considers the internal combustion engine destined to be the prime mover of the future. Discusses its de-

velopment, economy, etc. General discussion. Ills. 70000 w. Jour W Soc of Engrs—Feb., 1906. No. 75419 D.

Gas Producers.

Gas Producers for Power. Julius Wile. From a paper read before the Technology Club, Syracuse, N. Y. Discusses gas producers and the saving in cost, and presents the advantages of the automatic system as manufactured by the company the author represents. 2500 w. Ir Age—March 8, 1906. No. 75425.

The Gas Producer Power Plant. C. B. Lamont. Examines the results obtained at the testing plant of the St. Louis Exposition, and reviews briefly the development of the gas engine, with the aim of showing its advantage from a purely monetary standpoint, under conditions existing on the Pacific Coast. Ills. 4400 w. Jour of Elec—March, 1906. No. 75468 C.

The Suction Gas Producer. W. H. Booth. An illustrated account of the suction gas producer, its general principle and object, describing types. 3700 w. Cassier's Mag—March, 1906. Serial, 1st part. No. 75611 B.

Gas Washing.

The Bianchi Cooling and Washing Apparatus for Blast Furnace Gases (Der Bian sche Reinigungs-und Kühl-apparat für Hochofengase). Fritz Krull. The gases are passed through a drum partly filled with water, and containing revolving perforated discs. 1800 w. Glasers Annalen—March 1, 1906. No. 75724 D.

Marine Motors.

Internal-Combustion Motors for Marine Service (Motori Marini a Combustione Interna). D. Cardile. A comparative review of the applicability of various types of motors to vessels, with especial reference to the Diesel Marine motor. 5000 w. Rivisa Marittima—Jan., 1906. No. 75790 G.

The Application of Combustion Motors for the Propulsion of War Ships (Zür Frage der Verwendbarkeit von Verbrennungsmotoren für die Fortbewegung von Kriegsschiffe). Emil Capitaine. An examination of the relative weights and radius of action for steam engines, Diesel motors and Capitaine motors. Two articles. 7000 w. Schiffbau—March 14, 28, 1906. No. 75761 each D.

The Parsons Marine Motor. Illustrates and describes an internal combustion engine, specially designed for Marine work. It uses either petrol, paraffin, or alcohol as a fuel. 2000 w. Autocar—March 3, 1906. No. 75494 A.

Motor Testing.

See Mechanical Engineering, Measurement.

Oil Engine.

Oil Engine Working with Crude Oil. Illustrates and describes an engine made in England and previously described which has been adapted to the use of crude oil. 600 w. Engng——March 2, 1906. No. 75507 A.

Pressures

Experiments on Explosive Mixtures of Illuminating Gas and Air (Untersuchungen Explosibler. Leucht-gas-Luftgemische). F. Hausser. A detailed account of the investigation of pressures and associated phenomena caused by the ignition of various explosive gas mixtures in a closed chamber. 4500 w. Zeitschr d Ver Deutscher Ing—Feb. 17, 1906. No. 75701 D.

The Pressure of Explosives. Experiments on Solid and Gaseous Explosives. J. E. Petavel. From Phil. Trans. of the Roy. Soc. of London. An illustrated article giving detailed description of methods and of apparatus used. 3800 w. Sci Am Sup—March 24, 1906. Serial, 1st part. No. 75638.

Vaporiser.

The Westmacott Paraffin Vaporiser. Illustrated description of a vaporiser whereby ordinary lamp oil can be substituted for petrol with internal combustion engines, particularly for marine motors. 900 w. Auto Jour—Feb. 24, 1906. No. 75362 A.

HEATING AND COOLING.

Central Plant.

Reconstructing a Central Power and Heating Plant. Describes the reconstruction of a plant at Garden City, Long Island, supplying a cathedral, two school buildings, and other buildings, with the object of saving fuel. Ills. 2000 w. Heat & Vent Mag——March, 1906. No. 75623.

Dormitories.

Some Data Relating to the Heating of the Edgar F. Smith House Dormitories, University, Pennsylvania. H. W. Spangler. The University Dormitories are a group of 21 buildings under a common roof. Describes a direct radiation system of steam heating. 2500 w. Jour Fr Inst—March, 1906. No. 75558 D.

Dwellings.

Unwholesome Air in Dwellings. Albert Levy, in *La Technique Sanitaire*. Translation. Defective heating and lighting apparatus shown to be responsible for much of the bad air. 1600 w. Heat & Vent Mag—March, 1906. No. 75625.

Fan System.

A Fan System of Furnace Heating. Illustrated description of a heating and ventilating system for an eight-room school in Summit, N. J. 2000 w. Met Work—March 24, 1906. No. 75646.

We supply copies of these articles. See page 319.

Hot Water.

Calculations and Requirements for Central-Station Heating. Discussing the Schott system for heating circulating water by exhaust steam, the hot water being distributed by circulating pumps. Ills. 2500 w. Elec Rev, N. Y.—March 24, 1906. No. 75666.

Ice-Plants.

Economy of Combination Compression —and Absorption—Plate Ice-Plants. Henry Torrence. Read before the Am. Soc. of Refrig. Engrs. Gives a comparison of the compression and absorption-systems showing that economy is gained by combining the two. 1400 w. Stevens Ind—Jan., 1906. No. 75535 D.

Refrigeration.

Rise of Temperature in Cold Stores. Reviews an article by M. Desvignes, in *L'Industrie Frigorifique*, comparing different methods employed in France for the refrigeration of insulated stores, and giving an analysis of the laws governing the loss of cold which takes place. 2000 w. Engr, Lond—March 19, 1906. No. 75604 A.

Theater.

Heating and Ventilating the New Montauk Theater, Brooklyn, New York. Illustrated description of a recent type of upward ventilation. Both direct and indirect radiation are used. 900 w. Heat & Vent Mag—March, 1906. No. 75624.

HYDRAULICS.

Hydraulic Machinery.

The Selection of Material for the Construction of Hydraulic Machinery. Arthur Falkenau. Notes on the determining factors in the selection of the materials to be used. 1800 w. Jour Fr Inst—March, 1906. No. 75557 D.

Pumping.

See Civil Engineering, Water-Supply.

Pumps.

The Centrifugal Pump and Its Application. Harry Y. Haden. Gives examples illustrating the working conditions and showing the efficiency, reporting a test on an electro-motor pump of 1200 gallons a minute capacity and 45 feet head. 1200 w. Jour of Elec—March, 1906. No. 75470 C.

The Development of the Single Steam Pump. S. J. Berard and W. C. McLeod. An illustrated article giving a general idea of the uses of various types of pumping engines, with detailed descriptions. 2200 w. Yale Sci M—March, 1906. No. 75823 C.

Pump Speeds.

The Minimum Rotative Speed of Pumps (Die Kleinste Mögliche Umlaufzahl von Pumpwerken). G. Goldstein. Discussing especially fly-wheel pumps and comparing the computed minimum speeds with those observed in practice. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 17, 1906. No. 75703 D.

Turbines.

Pressures in the Rotating Mass of Water and Axial Thrust in a Francis Turbine with Horizontal Shaft (Die Drückverhältnisse in einer um eine Horizontale Achse Rotierenden Wassermasse undder Achsiale Schub bei Francis Turbinen mit Liegender Wolle). Dr. Karl Kobes. An analytical and graphical examination of the pressures in unbalanced horizontal turbines. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—March 2, 1906. No. 75734 D.

Water Meters.

See Civil Engineering, Measurement.

MACHINE WORKS AND FOUNDRIES

Axle Factory.

Methods of a Modern Vehicle-Axle Plant. Charles A. Trask. Illustrated detailed description of methods in use at a plant in Jackson, Michigan. 2500 w. Am Mach—Vol. 29, No. 12. No. 75641.

Band-Saw.

Electrically-Driven Band-Saw for Metal. Illustrations, with short description. 500 w. Engng—March 16, 1906. No. 75806 A.

Bearings.

Ball and Roller Bearings. Henry Hess. Abstracted from the discussion on bearings at the N. Y. meeting of the A. S. M. E. A brief review. Ills. 2200 w. Am Mach—Vol. 29, No. 11. No. 75520.

The Performance of a Large Experimental Bearing. Albert Kingsbury. A contribution to the discussion at the Dec., 1905, meeting of the A. S. M. E. Illustrated account of tests made by the Westinghouse Electric and Manufacturing Co., at the East Pittsburg Works. 1000 w. Am Mach—Vol. 29, No. 11. No. 75519.

Boring Mill.

Designing a Boring Mill. Gives the reasoning of the author in preparing a design for a boring mill of 6 feet swing to take 48 inches under the cross rail. Ills. 3500 w. Am Mach—Vol. 29, No. 10. No. 75426.

Cams.

Notes on the Cam Chart. John Roy. On the laying out of cam charts, with a comparison with article published by C. F. Smith. 1500 w. Am Mach—Vol. 29, No. 11. No. 75517.

Cores.

Core Oil and Oil Cores. W. P. Henemann. An illustrated article discussing the making of cores. Foundry—March, 1906. No. 75422.

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Principles and Practice of Coremaking. Robert Buchanan. Abstract of a paper read before the Staffordshire Iron & Steel Inst. Discussing core boxes, cores, and core-making, rods, venting, drying, loam cores, etc. 4500 w. Ir & Coal Trds Rev—March 9, 1906. No. 75595 A.

Cupolas.

Distribution of Blast in Modern Cupola Practice. William H. Coleman. Aims to show the effects of high and low pressures on the melting capacities of cupolas, and on the cupola itself, as well as on the product. 1500 w. Ir. Trd Rev—March 29, 1906. 75838.

Drafting.

Shop Hints for Structural Draftsmen. John C. Moses. The present article considers the templet shop and discusses the possible saving of expense. Ills. 3000 w. Eng News—March 22, 1906. Serial, 1st part. No. 75649.

Drawing Presses.

Progress in the Construction of Drawing Presses (Fortschritte im Räderziehpresenbau). Karl Musiol. An examination of cam roller drawing presses, showing the influence of the elasticity of the machine parts upon its action. Serial, Part I. 2500 w. Stahl u Eisen—March 1, 1906. No. 75744 D.

Electric Driving.

Electric Driving in Shipyards. Illustrates and describes interesting installations at Sunderland, England, for driving machine tools. 1600 w. Engr, Lond—March 2, 1906. No. 75514 A.

Electricity in the Foundry. H. S. Knowlton. An illustrated article calling attention to the variety of uses to which electricity has been applied in the foundry. 1500 w. Cassier's Mag—March, 1906. No. 75609 B.

Some Notes on Motor Driving. W. J. Belsey. Describes some novel applications of motor driving and considers the type of motor most suitable for the operation of various machines. Ills. 3000 w. Elec Engr, Lond—Feb. 23, 1906. Serial, 1st part. No. 75369 A.

See also Mining and Metallurgy, Iron and Steel.

Foundry.

A Puzzling Bit of Foundry Work. C. Metcalf. An illustrated description of the making of a double-grooved drum, at iron works in South Brooklyn. 1000 w. Sci Am—March 31, 1906. No. 75827.

Foundry Practice. William A Bole. Abstract of a paper read before the Pittsburgh Found. Assn. Discusses the use of scrap requirements of castings, bad castings, flasks and outfit. 5500 w. Foundry—March, 1906. No. 75421.

Gear Cutting.

The Bevel-Gear Cutting Machine of Ducommun at Mulhouse in Alsace (Die Kegelrad hobelmaschime der Werk-stätte für Maschinenbau un vorm. Ducommun in Mülhausen). Hermann Fischer. Describing a bevel-gear cutting machine on the Bilgram principle, developing the theoretical form of tooth as it is cut. 1500 w. Zeitschr d Ver Deutscher Ing—March 10, 1906. No. 75710 D.

Molding.

Foundry Molds and Their Production. E. L. Rhead. Considers green sand moulds, dry sand moulds, loam moulds, and moulding operations. 3500 w. Mech Engr—March 10, 1906. No. 75585 A.

Molding Sand. H. E. Field. Read before the Pittsburgh Found. Assn. Considers the materials which make a good molding sand, and the properties that are desirable. 2800 w. Ir Age—March 15, 1906. No. 75516.

The Moulding of Bulky Pieces in a Contracted Space (Knapper-Raum—Sperrige Stücke). J. Leber. Describing the molding of a large flywheel with grooves for rope driving, the run being swept up in the sand. 1800 w. Stahl u Eisen—March 1, 1906. No. 75745 D.

Molding Machine.

The "Leeds" Hand-Press Molding-Machine. Illustrated description of the machine and method of making molds. 1200 w. Engng—Feb. 23, 1906. No. 75374 A.

Pipe.

Concerning Steel Pipe. Extracts from a paper by Frank N. Speller, published in the *Journal* of the Canadian Mining Inst. Considers the corrosion, and the threading. 2200 w. Locomotive—Jan. 1, 1906. No. 75537.

Pistons.

Experiments upon the Strength and Deflection of Pistons (Versuche zur Ermittelung der Durchbiegung und der Widerstandsfähigkeit von Scheibenkolben). C. Bach. A description of experimental apparatus for determining the actual deflection of pistons under pressure. 1200 w. Zeitschr d Ver Deutscher Ing—March 10, 1906. No. 75711 D.

Shop Methods.

New Shop Methods from the Machinist's Point of View. W. Burns. The influence of modern shop methods upon the training of the all-round mechanic, and the future of the individual workman. 2000 w. Engineering Magazine—April, 1906. No. 75789 B.

Shops.

A Large and Well Designed Crane Shop. Illustrated detailed description of a plant at Milwaukee, Wis. 2800 w. Ir Trd Rev—March 1, 1906. No. 75313.

The Shops and Some of the Methods of the Norton Grinding Company. Illustrates and describes new shops in Worcester, Mass., and the methods employed.

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4200 w. Am Mach—Vol. 29, No. 9. No. 75301.

See also Railway Engineering, Permanent Way and Buildings.

Threading Devices.

An Opening Taper-Threading Die and a Collapsing Pipe-Tap. Illustrated description of interesting devices, with explanation of their use. 1000 w. Am Mach—Vol. 29, No. 11. No. 75518.

Turret Lathes.

Complete Scheme for Turret Lathe Fixture with Special Set of Tools. C. V. Raper. Gives operations and tool lists, with illustrations of the samples of finished work. 1000 w. Mach, N. Y.—March, 1906. No. 75237 C.

Valve.

A Nine-Foot Valve. Robert Shirley. Illustrates and describes the method of making the pattern and mold for these valves. 1500 w. Foundry—March, 1906. No. 75423.

Welding.

The Autogenous Welding of Metals (La Soudure Autogene des Metaux). P. Dumesnil. A study of the practical use of the oxy-hydrogen and oxy-acetylene blow pipes; with an examination of the thermal reactions, and data as to cost of operation. 6000 w. Mem Soc Ing Civ de France—Nov., 1905. No. 75726 G.

MATERIALS OF CONSTRUCTION

Alloys.

Iron-Carbon Alloys with High Percentages of Carbon. F. Wust in *Metallurgie*. Translation. An experimental study, giving analyses, micro-photographs and cooling curves and discussing results. 3000 w. Ir & St Mag—March, 1906. No. 75630 D.

Valuable Alloys. Translated from Krupp "*Die Legierungen.*" Information concerning the constituents and properties of a number of alloys. 2700 w. Sci Am Sup—March 17, 1906. No. 75556.

Fatigue.

Season-Cracking of Brass and Bronze Tubing. Edwin S. Sperry. From *The Brass World*. Considers the fatigue of the metal to be the cause of the season-cracks, and that hydraulic drawing-benches cause this condition. 2500 w. Mech Engr—March 10, 1906. No. 75584 A.

Lubricants.

The Engineering Value of Lubricating Oils. William F. Parish, Jr. Abstract of a paper read before the N. E. Coast Inst. of Engrs. & Shipbldrs. Reports a comparative power test made by experts, and gives other information in regard to lubrication. 2500 w. Ir & Coal Trds Rev—March 16, 1906. No. 75810 A.

Manganese-Bronze.

Manganese Bronze and Its Manufacture. Abstract from an article by Edwin S. Sperry in *The Brass World*. Gives the history, theory, analysis, etc. 3000 w. Sci Am Sup—March 31, 1906. No. 75829.

Metals.

The Internal Architecture of Metals. Editorial review of a lecture by Prof. J. O. Arnold, before the Royal Institution. 1500 w. Engng—March 2, 1906. No. 75509 A.

Tool Steels.

Tests of High-Speed Tool Steels on Cast Iron. L. P. Breckenridge and Henry B. Dirks. Description, with illustrations, of experiments made in the shops at the University of Illinois. 3300 w. Am Mach—Vol. 29, No. 10. No. 75427.

MEASUREMENT

Accelerometers.

Acceleration and Accelerometers. A. P. Trotter. Read at the Junior Inst. of Engrs. Explains the principle of the accelerometer and its behavior. 3000 w. Engng—March 9, 1906. No. 75602A.

Automobile Testing.

A Modern Testing Plant for Gasoline Automobile Motors. Dr. Alfred Gradenwitz. Brief illustrated description of a testing plant in Berlin. 700 w. Sci. Am. Sup—March 3, 1906. No. 75323.

Measuring Power at the Road Wheels. Illustrates and describes the testing plant at Purdue University at Lafayette, Indiana, its construction and action. 2200 w. Auto Jour—March 3, 1906. No. 75493A.

Centrifugal Force.

Experiments on the Strength of Rotating Disks (Versuche über die Festigkeit Rotierender Scheiben). M. Grubler. An account of the continuation of the author's experiments to determine the bursting speeds of emery wheels and similar disks 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 24, 1906. No. 75706 D.

Curves.

The Holbrook Spiral Curve. Prof. W. D. Taylor. Reprinted account of the properties of this curve and of its use. 1000 w. Wis Engr—Feb., 1906. No. 75311 D.

Dynamometer.

Bailey's Dynamometer. Brief Illustrated description of a design that will indicate automatically the number of revolutions, and the weight or degree of resistance. 400 w Mech Engr — March 17, 1906. No. 75697 A.

Flexure.

A Complete Analysis of General Flexure in a Straight Bar of Uniform Cross-Section. L. J. Johnson. States the

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problem and gives the solution. 7000 w. 1 plate. Prs Am Soc of Civ Engrs—Feb., 1906. No. 75341 E.

Impact.

Collision, Direct and Oblique, With and Without Friction. Robert H. Smith. The present number is a study of "normal central impact" which produces no tangential force and no spinning in the masses. 2500 w. Engr, Lond—Feb. 23, 1906. Serial, 1st part. No. 75377 A.

Indicator.

An Improved Stress-Strain Indicator. Describes the action of an ingenious instrument, recently patented by A. Suggate, which is capable of measuring stresses of any kind in any material that is undergoing a strain. 2000 w. Prac Engr—March 2, 1906. No. 75495 A.

Standards.

Standards of Length. Herbert T. Wade. Information concerning the two meter bars in the custody of the National Bureau of Standards at Washington, and the care given them. Also the uses to which they are applied. Ills. 1200 w. Sci Am—March 10, 1906. No. 75429.

POWER AND TRANSMISSION

Air-Compressors.

An Air-Compressor Test. John Howatt. Summary of a test made at Oelwein, Iowa. 900 w. Eng & Min Jour—March 24, 1906. No. 75662.

Elevator Equipment.

The Electrical Equipment of a Two-Million-Bushel Grain Elevator. Illustrates and describes the equipment of the operating elevator at Weehawken, N. J., belonging to the N. Y. C. & H. R. R. R. 1400 w. Elec Rev, N Y—March 17, 1906. No. 75560.

Regulation.

The Influence of Elastic Connections upon the Regulation of Rotating Motors (Die Elastische Verbindung der Rotierenden Massen und ihr Einfluss auf den Reguliervorgang des Motors.) Philipp Ehrlich. A discussion of the mechanical problems of speed regulation, showing the influence of the torsional elasticity of shafts, couplings, etc., upon the regulation of heavy machinery. 4500 w. Zeitschr d Oesteri Ing u Arch Vei—March 9, 1906. No. 75736 D.

STEAM ENGINEERING.

Boiler Explosion.

The Boiler Explosion on the "Bennington." An account of the accident which occurred July 21, 1905, on the Pacific Coast. Also reviews the investigation of the cause as given in the Report of the Court of Inquiry. 3300 w. Locomotive—Jan., 1906. No. 75538.

Boilers.

Boiler Efficiency Tests. George T. Hanchett. Describes methods of making these tests, which the writer has found convenient. 2500 w. Elec Wld—March 3, 1906. No. 75355.

Large Locomotive Boilers. G. J. Churchward. Gives 16 plates of boiler designs, with a short paper discussing recent improvements and present practice. 2500 w. Inst of Mech Engrs—Feb. 16, 1906. No. 75308 D.

Corrosion.

Corrosion and Its Effects in Steam Boilers. William H. Fowler. The present number considers the corrosion of external surfaces. Ills. 1000 w. Mech Engr—March 10, 1906. Serial, 1st part. No. 75583 A.

Fuel Oil.

Burning Fuel Oil. J. E. Anderan. An Illustrated description of a fuel oil system for a 300-h. p. plant, built to comply with the insurance rules. 1200 w. Engr, U S A—March 1, 1906. No. 75336 C.

Fuel Value.

The Fuel Value of Some Tennessee and Kentucky Coals. Charles A. Ferris. A description of the Parr Calorimeter and the results obtained in using it. 1400 w. Mines & Min—March, 1906. No. 75452 C.

Governors.

The Action of Governors. E. E. Russell. Gives analysis of the action of a governor, and explains the principle of the flyball governor. Ills. 1000 w. Engr, U S A—March 1, 1906. No. 75335 C.

Mechanical Draught.

The Conditions of Mechanical Draught Production. Walter B. Snow. Discusses the economy, methods of application, losses, efficiency, &c. 3800 w. Cassier's Mag—March, 1906. No. 75610 B.

Portable Engines.

The Development of the Wolf Portable Engine (Die Entwicklung der Lokomobilen von R. Wolf). Karl Heilman. A review of the growth of the portable and semi-portable engine and boiler, to the production of the modern compound type, using superheated steam and giving maximum efficiency. Serial, Part I. 3500 w. Zeitschr d Ver Deutscher Ing—March 3, 1906. No 75708 D.

Smoke.

Smoke Prevention in the Modern Power Station. John B. C. Kershaw. Discusses means of improving the efficiency of the boiler plants. 2500 w. Power—March, 1906. No. 75382 C.

Steam Accumulator.

The Rateau System for the Utilization of Exhaust Steam from Engines of Intermittent Action (Das Rateausche Verfahren Zur Verwertung des Abdampfes von Maschinen mit unter brochenam Betrieb). A. Heller. An account of the application of the Rateau accumulator and low-pressure steam turbine to the

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utilization of exhaust steam. 2500 w. Zeitschr d Ver Deutscher Ing—March 10, 1906. No. 75709 D.

Steam Turbines.

Installation of a Low-Pressure Steam Turbine. An illustrated description of the conditions, and the plan so far as worked out, for the installation of a 500-K. W. low-pressure, direct-current turbine-driven unit in a power house near Scranton, Pa. 800 w. Power—March, 1906. No. 75383 C.

Steam Turbines. W. H. Booth. Remarks on trouble with the blades of steam turbines, due chiefly to the stripping-out of blades under the influence of something deleterious to them, discussing the cause. 1400 w. Elec Rev, Lond—March 2, 1906. No. 75500 A.

Test on a 1500 K. W. Curtis Turbine. Reports steam consumption tests on a Curtis turbo-alternator set running at the electricity works of the County of London Electric Supply Co. 700 w. Elect'n, Lond—March 2, 1906. No. 75502 A.

The Effect of Admission Pressure on the Economy of Steam Turbines. T. Stevens and H. M. Hobart. An examination of the results of tests on steam-turbines of the Parsons type, giving curves and tables. 3300 w. Engng—March 2, 1906. Serial, 1st part. No. 75510 A.

Superheating.

Can Superheated Steam Contain Water? (Beitrag zur Frage: Kann übernitzer Dampf Wasser Enthalten?) Fritz L. Richter. Data and results of experimental investigations, showing that entrained water cannot exist in pipes in which the steam is superheated 30 degrees C. above saturation temperature. 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 24, 1906. No. 75705 D.

Notes on Superheated Steam. J. R. Bibbins. Discusses important things in order to determine the ultimate commercial value of superheat. 2500 w. Elec Jour—March, 1906. No. 75628.

Valves.

Development of Valves and Valve Motion. Angus Sinclair. An illustrated article reviewing the history of steam engine valves and describing types. 4000 w. Ry & Loc Engng—March, 1906. Serial. Part I. No. 75487 C.

MISCELLANY.

Aeronautics.

Count von Zeppelin's Dirigible Airship. Reviews the experiments with this airship, and gives an illustrated description of improvements recently introduced. 1300 w. Sci Am—March 3, 1906. No. 75321.

Some Recent Foreign Flying Machines. Illustrates and describes some of the latest attempts at solving the problem of flight. 1700 w. Sci Am.—March, 1906. No. 75636.

Oxygen.

The Use of Liquid Air in the Manufacture of Oxygen and Nitrogen (La Liquéfaction de l'Air et ses Applications à la Fabrication Industrielle de l'Oxygène et de l'Azote). Georges Claude. A detailed account of the commercial production of oxygen as now actually conducted in France, by the rectification of liquid air. 7000 w. Mem Soc Ing Civ de France—Nov., 1905. No. 75729 G.

MINING AND METALLURGY

COAL AND COKE

Anthracite.

Virginia Anthracite Field. J. E. Tiffany. Describes a region showing coal formations, the values of which have not yet been thoroughly proved by prospecting. 3500 w. Mines & Min—March, 1906. No. 75455 C.

Coal Cutting.

Tubular Drills for Coal Cutting (Bohr und Schrämmaschine mit Kernbohrwerkzeug). Dr. Tübben. Describing the successful use of core drills for coal cutting in the Friedrichsthal mine at Saarbrück. 1800 w. Glückauf—Feb. 24, 1906. No. 75737 B.

Coal Tips.

New Coal Tips at Garston Docks. Illustrates and describes two powerful hydraulic coal tips for the London and North-Western Railway Company, erected near Liverpool. 700 w. Engr. Lond—March 16, 1906. No. 75803 A.

Coal Trade.

See Industrial Economy.

Disaster.

Explosion at Courrieres Colliery. An account of the terrible disaster in France on March 10, 1906. 2200 w. Col Guard—March 16, 1006. No. 75696 A.

The Coal Disaster in France. Donald F. Campbell. An illuustrated article briefly describing the Pas de Calais mines and their equipment, where a disaster costing over 1200 lives, recently occurred. 1000 w. Min & Sci Pr—March 17, 1906. No. 75673.

Electrical Plant.

How to Avoid Accidents with Electrical Machinery in Coal Mines. H. Morton Middleton. Aims to show that if care is taken with the selection and in-

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stallation of the plant, and it is given intelligent supervision, it will prove the safest and most economical form of power that can be used in a colliery. 3500 w. Col Guard—March 16, 1906. No. 75695 A.

National Mining Company's Mines. Illustrated description of coal mines where electricity is applied to nearly every purpose below or above ground, and chain hauls are used in the main slope. 2000 w. Eng & Min Jour—March 10, 1906. No. 75461.

Filling.

The Hydraulic Filling of a Coalseam at Lens, Pas-de-Calais, France. Lionel E. Hill and Malcolm Burr. Abstract of a paper read before the Inst. of Min. and Met. Describes the process as applied at the colliery named. Ills. 2000 w. Col Guard—March 2, 1906. No. 75505 A.

Lancashire.

Half a Century of Lancashire Coal Mining. Jno. Unsworth. Read before the Nat. Assn. of Colliery Mgrs. A review of mining conditions, production, accidents, wages, legislation, improvements, &c. 9500 w. Ir & Coal Trds Rev—March 16, 1906. No. 75809 A.

Operation.

The Operation of a Coal Mine. Thomas A. Jackson. Discusses the essential principles in regard to production, transportation and preparation of the coal. 3500 w. Mines & Min—March, 1906. No. 75459 C.

The Springfield Coal Mine of the Peabody Coal Co., and the Method of Survey. Mr. F. Peltier. Abstract of a paper read at meeting of the Illinois Soc. of Engrs. & Survs. Describes this modern coal mining plant in Illinois. 1500 w. Eng News—March 8, 1906. No. 75437.

Workings.

Late Methods of Rib Drawing. Elias Phillips. Read before the Coal Min. Inst. of America, at Pittsburg, Pa. Illustrates and describes improved methods applied in the Connellsville seam, discussing the importance of taking out a large percentage of coal. 3200 w. Mines & Min—March, 1906. No. 75460 C.

COPPER

Copper.

The Reign of Copper. Percy E. Barbour. Part I gives an historical review of the uses made of copper from the earliest times, and its commercial importance. Part II gives information of the copper mining districts of the United States. 5000 w. Jour Worcester Poly Inst—March, 1906. No. 75515 C.

Crushing.

Gigantic Crushing of Copper Ore. A. S. Atkinson. Report of the steam stamp of 700 tons per day capacity, and of other methods of crushing in the Lake Superior region. 2500 w. Mines & Min—March, 1906. No. 75453 C.

Smelting.

Pyrite Smelting Without Coke. Lewis T. Wright. On the extraction of copper from cupriferous pyrite, reviewing the English method, and giving an account of results obtained by the writer. 3000 w. Min & Sci Pr—Feb. 24, 1906. No. 75327.

GOLD AND SILVER

Assaying.

Notes on Gold Assay Methods (Beiträge zum Goldprobierverfahren). Leopold Schneider. A review of the development of assaying processes for the separation of gold, with especial reference to silver and lead alloys. Two articles. 5000 w. Oestern Zeitschr f Berg u Hüttenwesen—Feb. 17, 24, 1906. No. 75738 each D.

British Columbia.

Progress of Mining in the Similkameen District. George E. Winkler. Briefly reviews the mining history of this gold and copper region, describing especially the progress during the year 1905. 3000 w. B. C. Min Rec—Jan., 1906. Serial. 1st part. No. 75312 B.

Cobalt.

Cobalt. D'Arcy Weatherbe. Information concerning the silver-nickel-cobalt mine in Ontario, Canada. 2500 w. Min & Sci Pr—March 10, 1906. No. 75563.

Comstock.

The Comstock in 1876. View of Virginia City as it looked thirty years ago, with interesting review of its noted gold and silver mine. 2500 w. Min & Sci Pr—Feb. 24, 1906. No. 75326.

Concentration.

The Baggaley Pyritic - Conversion Process. Describes this process which is designed to effect the concentration of any kind of copper, gold, or silver ore. 3500 w. Eng & Min Jour—March 24, 1906. No. 75663.

The Cactus Mill at Newhouse, Utah. Illustrates and describes a modern concentrating plant of one thousand tons daily capacity. 3300 w. Mines & Min—March, 1906. No. 75449 C.

Cyanide.

Modern Cyanide Plants. John E. Rothwell. Concerning the improvements recently introduced in the arrangement and operation of cyanide plants. 2000 w. Min Wld—March 24, 1906. No. 75675.

Dumps.

A Proposed Method of Treating Sand Residue Dumps. S. J. Truscott and A. Yates. Outlines the proposed scheme of treatment. 1000 w. Jour Chem, Met & Min Soc of S. Africa—Jan., 1906. No. 75596 E.

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Gold.

Gold and Its Chemistry. G. T. Beilby. Abstract of an address before the S. African meeting of the Brit. Assn. for the Adv. of Science. The influence of iron and of gold upon the world's progress is discussed, and the chemical development of metallurgy and its application to gold recovery. 1800 w. Sci Am Sup—March 10, 1906. No. 75431.

Guiana.

Notes on Dutch Guiana. E. H. Teats. Information concerning the geography, mining laws, auriferous deposits, etc. Ills. 3000 w. Eng & Min Jour—March 24, 1906. No. 75661.

Mexico.

Mining in Western Chihuahua. W. Spencer Hutchinson. An illustrated account of the mines of this region, the gold value being the most important, although silver is also found and other minerals of value. 1200 w. Eng and Min Jour—March 3, 1906. No. 75334.

Ore Deposits.

The Pribram Ore Deposits (Neues über das Pribramer Erzvorkommen). A. Hofmann. Discussing the recent developments of silver bearing galena in the Pribram mining district of Bohemia. 2000 w. Oesterr zeitschr f Berg u Hüttenwesen—March 10, 1906. No. 75741 D.

Placers.

Giant Hydraulic Placer Mining in Oregon. A. S. Atkinson. Explains the great difficulties encountered in working high elevations, and describes the pumping of water with turbines against a head of 430 feet for operating giant nozzles. 1700 w. Mines & Min—March, 1906. No. 75454 C.

Soudan.

Ancient Gold Fields of the Soudan. T. Buxton. Information concerning these old mines and the methods used in working them. 1500 w. Min Jour—Feb. 24, 1906. No. 75370 A.

Stamp-Milling.

Stamp-Milling in Northern California. Algernon Del Mar. Describes a series of tests at the Edel mill, discussing the results. Ills. 2200 w. Min & Sci Pr—March 3, 1906. No. 75445.

Wyoming.

Mineral Resources of Northeastern Wyoming. A statement of the mineral resources of Crook County, Wyoming, in the vicinity of Sundance. Gold, copper, silver, lead, coal, gypsum, bentonite, and limestone are found. 2500 w. Min Rept—March 22, 1906. No. 75671.

IRON AND STEEL

Blast Furnaces.

A Graphic Method for the Computation of Blast Furnace Charges. C. O. Bannister. From *Trans. of Inst. of Min. & Met.* Explains the preparation of the diagram and gives an example of the calculation, and of the method of regulating the charge from the analysis of the slag produced. 600 w. Ir & St Mag—March, 1906. No. 75631 D.

Technical Progress in Blast-Furnace Practice (Technische Fortschritte im Hochofenwesen) Oskar Simmersbach. Discussing the briquetting of iron ores, the use of mechanical conveyors and handling apparatus, and the general development of mechanical appliances. Serial, Part I. 3500 w. Stahl u Eisen—March 1, 1906. No. 75743 D.

Dry Blast.

New Developments in Dry Blast. A Steinbart. Read before the Technische Verein, Pittsburg. Refers to results obtained by Mr. James Gayley, and the theory of Mr. J. E. Johnson, giving also the writer's reason why there is in a dry blast furnace less heat necessary, per pound of iron made, for reactions below the critical temperature. 1800 w. Ir Trd Rev—March 15, 1906. No. 75540.

Electric Smelting.

The Development of the Electric Smelting of Iron and Steel (Die Weitere Entwicklung der Elektrischen Verfahren zur Herstellung von Eisen und Stahl). Dr. Albert Neuburger. A review of recent progress with especial reference to the work of Kjellin, Schneider, and Gin. 5000 w. Glasers Annalen—March 15, 1906. No. 75752 D.

Iron Ore.

The Northern Iron Fields. M. P. Youngs. Information concerning the ore traffic on the Minnesota railroads, the development work in progress, etc. 2000 w. Min Wld—March 3, 1906. No. 75350.

Re-Rolling.

The Works of the English McKenna Process Company. Describing the new plant at Birkenhead for re-rolling old and worn rails; including grinding machinery, heating furnaces, rolling mills, and general mechanical equipment. 3000 w. Engn'g—March 2, 1906. Serial, Part I. No. 75506 A.

Rolling Mills.

Methods of Driving Rolling Mills. A comparison of the effectiveness of steam power and electric motors for driving rolling mills, advocating electric driving, with gas engines as prime movers. Abstract from paper by H. Ortman in *Stahl und Eisen.* 2800 w. Ir Age—March 8, 1906. No. 75424.

The Large Wire-Rod Rolling Mills of The Phoenix Works at Hamm. Westphalia (Die Grosse Drahtstrasse der A. G. Phoenix zu Hamm i. w.) with plan of the mill, and illustrated description of the triple-expansion engines of 2000 h. p.

We supply copies of these articles. See page 319.

2000 w. 2 plates. Stahl u Eisen—March 1, 1906. No. 76742 D.

Separators.

Magnetic Separators (Les Séparateurs Magnétiques). L. Fabre. Illustrated description of various types of machines for separating magnetic ores from rock, sand, and other impurities. Two articles. 3000 w. L'Electricien—Feb. 17, 24, 1906. No. 75766 Each B.

MINING.

Cages.

Cage and Landing Chairs. R. D. O. Johnson. Describing the drop-bottom type of cage for use in deep mine hoists. The movable portion of the cage bottom holds the car securely during transit, and, with the accompanying landing chair, permits prompt unloading. Ill. 1400 w. Eng & Min Jour—March 3, 1906. No. 75333.

Camps.

The Beginning of a Mining Camp. Prof. Arthur Lakes. Describes the starting point of a typical rough camp in the west. Ills. 1300 w. Mines & Min. March, 1906. No. 75450 C.

Drills.

Air-Hammer Rock-Drills. Edward A. Rix. Abstract of a paper before the California Miners' Convention, on the advantages of these drills. 2800 w. Min & Sci Pr—Feb. 24, 1906. No. 75329.

Electric Power.

Electricity at European Oil Wells. George E. Walsh. The dangers of present methods are discussed, and the avoiding them by installation of central stations and electric transmission. 2500 w. Mines & Min—March, 1906. No. 75457 C.

The Use of Electricity in Mines. R. G. Mercer. Abstract of a paper read before the Birmingham and District Electric Club. Considers its application to winding, haulage, pumping, coal-cutting, etc., discussing the distribution, systems, and economy. 3500 w. Elect'n, Lond—March 16, 1906. No. 75681 A.

Fans.

The largest Fan in Existence. Report some tests made at the Ronco mine, in Fayette Co., Pennsylvania, comparing with another large fan in regard to volume, size, and efficiency. Ills. 800 w. Mines & Min—March, 1906. No. 75456 C.

Faults.

Classification of Faults and Fractures into Series and Sets, and Its Practical Application. F. Julius Fohs. Abstracted from forthcoming reports on the deposits of western Kentucky. 1500 w. Eng & Min Jour—March 24, 1906. No 75660.

Hoisting.

Hoisting Methods at Butte. A. H. Wethey. An illustrated article giving the results of 18 years experience with hoisting in the mines of W. A. Clark, at Butte, Mon. 1500 w. Eng & Min Jour—March 10, 1906. No. 75462.

Tests upon the Weakening of Hoist-Cables from Broken Wires (Versuche über die Unsichere Drahtlänge bei Drahtbrüchen in Förderseilen) Hermann Kroen. Detailed report of tests of wire rope cables to ascertain the effect of the breaking of isolated wires. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 3, 1906. No. 75740 D.

Hydraulic Mining.

The Control of Hydraulic Mining in California by the Federal Government. William W. Harts. Explains the débris problem, describing the mining region and methods, the duties of the Commission, the general principles of improvement, etc. Ill. 11500 w. Pro Am Soc of Civ Engrs—Feb., 1906. No. 75342 E.

Ladders.

Making Mine Ladders. Matt. W. Alderson. Remarks on the requirements of mine ladders, with illustrations of types. 1200 w. Min & Sci Pr—Feb. 24, 1906. No. 75328.

Mining Law.

The Grand Central—Mammoth Decision. Describes the mines in dispute and reviews the second trial in the present number. 4300 w. Min & Sci Pr—Jan. 31, 1906. Serial, 1st part. No. 75562.

Ore Deposits.

The Genesis of Ore Deposits. C. O. G. Larcombe. Lecture before the Science Society of Sydney University, giving an explanation and comparison of recent theories. 4000 w. Aust Min Stand—March 10, 1906. Serial, 1st part. No. 75360 B.

Roasting.

Theoretical Aspects of Lead-Ore Roasting. C. Guillemain. Abstract translation from *Metallurgie*. Refers to some new processes of lead-ore roasting. The methods of Antouin Germot and of Huntington and Heberlein. 2200 w. Eng & Min Jour—March 10, 1906. No. 75464.

Safety Catches.

A Critical Examination of the Action of Safety Catches (Kritische Besprechung Gefährlicher Fall und Fangergebnisse). H. Undeutsch. An examination of the construction of safety catches on mine hoists, with especial reference to the permissible amount of drop before seizure. Two articles. 5000 w. Osterr Zeitschr f Berg u Hüttenwesen—March 3, 10, 1906. No. 75739 each D.

Screening.

A Traveling-Belt Screen. Illustrated description of this machine explaining the fundamental principle. 1800 w. Eng & Min Jour—March 10, 1906. No. 75463.

We supply copies of these articles. See page 319.

Shafts.

Allan Shafts. H. S. Patterson. Illustrated description of the progress in sinking and the methods employed at two shafts of the Acadia Coal Company, Nova Scotia. 900 w. Mines & Min—March, 1906. No. 75451 C.

Improved Shaft Equipment. S A. Worcester. Illustrates and describes an arrangement designed for handling ore at the Golden Cycle mine, Cripple Creek, Colo. It is claimed that it will save from $8 to $15 each 8-hour shift. 1500 w. Min & Sci Pr—March 17, 1906. No. 75672.

Sinking, Development and Underground Equipment of Deep Level Shafts on the Rand. Arthur E. Pettit. Read before the Inst. of Min. & Met. An illustrated description of methods of sinking and equipping shafts, with some figures relating to the cost. 4500 w. Ir & Coal Trds Rev—Feb. 23, 1906. Serial. 1st part. No. 73379 A.

Sinking Shafts for a Modern Colliery. Prof. F. W. Hardwick. The present lecture is confined to the sinking of shafts and the difficulties encountered. 10500 w. Jr & Coal Trds Rev—March 2, 1906. No. 75515 A.

Winding.

Electric Winding in Main Shafts Considered Practically and Commercially. W. C. Mountain. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Briefly considers the systems of winding, especially from a commercial standpoint. Does not favor electricity for heavy winding. 2500 w. Col Guard—Feb. 23, 1906. No. 75371 A.

Weight in Winding Drums. R. H. Collingham. Considers the weight of a conical drum with regard to the weight of a parallel drum of the same maximum diameter. Gives method used by writer. 1800 w. Engr, Lond—Feb. 23, 1906. No. 75376 A.

MISCELLANY.

Asbestos.

Concerning Asbestos. George P. Merrill. Gives a brief resume of the physical and chemical properties of the four varieties of asbestos on the market, the localities and mode of occurrence. 1500 w. Min Wld—March 24, 1906. No. 75676.

Distillation.

The Boiling and Distillation of Nickel Iron, Manganese, Chromium, Molybdenum, Tungsten and Uranium (Sur l'Ebullition et la Distillation du Nickel, du Fer, du Manganèse, du Chrome, du Molybdène, du Tungstène, el de l'Uranium). Henri Moissan. A study of the behaviour of the metals of the iron group in the electric furnace. 3500 w. Comptes Rendus—Feb. 19, 1906. No. 75720 D.

Platinum.

Researches on Metals of Platinum Groups. Prof. Henri Moissan. Paper read at Académie des Sciences. Gives experiments made with the ordinary form of Moissan furnace. 1500 w. Sci Am Sup—March 31, 1906. No. 75830.

Tungsten.

Tungsten Ore in Washington. M. H. Joseph. An account of the discovery. 700 w. Eng & Min Jour—March 3, 1906. No. 75332.

Uranium.

Uranium: Its Preparation, Gravimetric Determination and Occurrence, Victor Blanc. From the Trans. of W. Assn. of Tech. Chem. and Met. Information concerning the discovery, appearance, determination, uses, etc. 2000 w. Min Wld—March 10, 1906. No. 75475.

Zinc.

The Wisconsin Zinc District. H. A. Wheeler. Describes an old lead and zinc producing district which modern machinery and methods have rendered profitable. Map. 6000 w. Mines & Min—March, 1906. No. 75458 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION

Accident.

The Catesby Tunnel Accident. An account of the accident occurring last Jan. on the Great Central Railway. 1500 w. Engng—March 16, 1906. No. 75807 A.

Competition.

Competition Between Railway and River Transportation in the Early Part of the Railway Era: A Leaf from the History of the Hudson River R. R. Extract from an interesting paper by J. B. Jarvis, written in 1850, regarding the cost of transportation at that time. 4500 w. Eng News—March 22, 1906. No. 75651.

Train Dispatching.

See Street and Electric Railways.

Train Service.

How to Improve Passenger Service. R. Marpole. A paper (condensed) presented at a Canadian Pacific officers' conference at Field, B. C. Briefly considers the track, the equipment and care of passenger trains, and the manning of the trains with capable men. 200 w. R R Gaz—Vol. XL., No. 10. No 75.444.

We supply copies of these articles. See page 319.

MOTIVE POWER AND EQUIPMENT.

Acceleration.

Energy Expended on Car-Wheel Acceleration. A study explaining the method of calculation. 1000 w. Engng—March 9, 1906. No. 75599 A.

Air Brakes.

The New Westinghouse "K" Triple Valve. States the advantages and describes the action, giving information concerning its special features. Ill. 2500 w. R R Gaz—Vol. XL., No. 12. No. 75645.

Boilers.

See Mechanical Engineering, Steam Engineering.

Car Design.

Science Applied to Car Design. Illustrates and describes new features introduced in the Sullivan side-door car, used in suburban traffic on the Illinois Central Railroad. 1500 w. Ry & Loc Engng—March, 1906. No. 75489 C.

Car Hygiene.

Hygeine as Applied to Railway Coaches. Dr. J. M. Gassaway. Discusses the danger of infection, reporting tests made, and concluding that as long as coaches are cleansed and aired, the danger is of slight consequence. 4800 w. Pro St Louis Ry Club—Feb. 9, 1906. No. 75309.

Cars.

All-Steel Drop Bottom General Service Gondola Car for the Frisco System. Illustrated description of cars showing new points in design. 800 w. R R Gaz Vol. XL., No. 12. No. 75644.

Box Car for Automobiles. Illustrated description of a type of car being built at the Pennsylvania's shops for the transportation of automobiles. 600 w. Ry & Loc Engng—March, 1906. No. 75488 C.

Electric Locomotives

Electric Locomotives for the Simplon Tunnel (Locomotives Electriques pour le Tunnel du Simplon). S. Herzog. A general description of the Brown, Boveri three-phrase locomotives designed for the Simplon-tunnel service. 2000 w. 1 plate. Génie Civil—March 10, 1906. No. 75717 D.

Tests on Electric Railway Traction (Essais de Traction Electrique). P. Dumas. A report of tests with electric locomotives on the narrow gauge railroad of Saint-Georges-de-Commiers at La Mure, in the south of France. The electric current is derived from the works at Grenoble. 30,000 w. Ann des Ponts et Chausseés—4 Trimestre, 1905. No. 75778 E+F.

The Single Phase Electric Locomotive for Heavy Passenger and Freight Service. C. Renshaw. On the Development of the single-phase alternating current motor and its practical application for the electrical operation of trunk line service. Interesting discussion. Ills. 7000 w. Pro Ry Club of Pittsburgh—Dec. 22, 1905. No. 75626 C.

Fire Boxes.

Recent Investigations of Copper Fire Boxes (Neue Versuche mit Kupfernen Feuerbuchen). G. Dinglinger. A study of the behaviour of copper in the fire boxes of locomotive boilers as regards expansion, safety and efficiency. 2000 w. Glasers Annalen—March 15, 1906. No. 75751 D.

Inspection Cars.

Motor-Driven Inspection Cars for Railway Service. Illustrates one of the Sheffield Car Co.'s gasoline motor cars, and Olds single-cylinder railway motor car, with descriptive notes and general discussion. 1200 w. Eng News—March 8, 1906. No. 75439.

Locomotive Frames.

The Repairing of Locomotive Frames. From a paper read by S. Uren before the National Railroad Blacksmiths' Association. Illustrates and describes methods of welding. 1300 w. Am Engr & R R Jour—March, 1906. No. 75315 C.

Locomotives.

Compound Express Locomotive, Midland Railway. Two-page engraving showing a longitudinal section and sectional plan of the engine, with particulars of interest. 600 w. Engr, Lond—March 9, 1906. No. 75606 A.

Fast Passenger Locomotive for Heavy Service; Chicago, Milwaukee & St. Paul Ry. Illustration, with description of a design for a six-coupled engine of the Pacific type (4-6-2). A comparison with three other large engines is given. 1500 w. Eng News—March 15, 1906. No. 75521.

Heavy American Type Locomotive for the Central Railroad of New Jersey. Illustrated description of an 8-wheel passenger locomotive with Walschaert-valve motion. 500 w. Ry Age—March 16, 1906. No. 75576 .

Large Electric and Steam Locomotives. J. E. Muhlfeld. Gives a comparison of the performance of electric and steam locomotives in actual service, and discusses the requirements and results, and all matters of related interest. An important paper, with an interesting discussion. 17500 w. Pro N Y R R Club —Feb. 16, 1906. No. 75536.

New Locomotives, London, Brighton and South Coast Railway. Charles Rous-Marten. Illustration with remarks on the novel features, giving principal dimensions. 2000 w. Engr, Lond —Feb. 23, 1906. No. 75375 A.

Six-Coupled Tank Locomotive: Furness Railway. Illustrated description of a powerful 6-wheels coupled radial-tank engine, to be used for hauling heavy

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trains. 500 w. Mech Engr—March 17, 1906. No. 75699 A.

Locomotive Tests.

Comparisons Between the Efficiencies of an American and an Austrian locomotive (Vergleich der Leistungs fähigkeit einer Amerikamschen mit einer Oesterreichischen Lokomotive). R. Sanzin. The data for the American engine are taken from the P. R. R. tests at St. Louis; the Austrian data are from road trials on the Arlberg division of the Austrian State Railways. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 16, 1906. No. 75731 D.

Oscillations.

The Oscillations of Railway Vehicles on Entering and Leaving Curves (Les Oscillations du Materiel des Chemins de Fer à l'Entrée en Courbe et à la Sortie). Georges Marié. An exhaustive mathematical and practical study of the action of centrifugal and inertia forces to produce oscillations. 10000 w. Mem Soc Ing Civ de France—Nov., 1905. No. 75728 G.

Stability.

Stability of Trains on a Track of O-60 Metre Gauge (La Stabilité des Trains; La Voie de Om. 60). Col Péchot. Discussing especially the availability of track of about 24-inch gauge for military purposes, including details of construction and operation. 25,000 w. 1 plate. Ann des Ponts et Chaussées—2 Trimestre, 1905. No. 75771 E & F.

Stoker.

The Hayden Mechanical Stoker. Illustrated description of a stoker for use on the large locomotives of the present, its operation and test. 4500 w. R R Gaz—Vol. XL., No. 9. No. 75317.

Trucks.

The Radial Truck. Prof. C. A. Carus-Wilson. Lecture delivered before the Tram & Lgt. Rys, Assn. An illustrated article discussing points of interest connected with the working of the radial truck, and attempts made towards its more perfect development. 2500 w. Engng—March 16, 1906. No. 75808 A.

NEW PROJECTS.

Extension.

The Western Maryland Extension from Cherry Run to Cumberland. Ralph C. Davison. Illustrated description of an extension of 59.3 miles through a rough country. 5000 w. R R Gaz—Vol. XL., No. 11. No. 75545.

Improvements.

The Chicago & Eastern Illinois 1905 Improvements. Illustrates and describes extensive improvements made necessary by the heavy coal traffic, on the Chicago division of this line. 3000 w. R R Gaz—Vol. XL., No. 11. No. 75547.

India.

Railway Construction in India. Gives views and brief notes concerning the work. 500 w. Engr, Lond—March 16, 1906. No. 76802 A.

New Line.

The Western Pacific. An account of this new line being built from San Francisco to Salt Lake City to serve as a Pacific connection for the Gould system of railroads. Map. 1200 w. R R Gaz—Vol. XL., No. 11. No. 75546.

Projected Railways.

Projected International Railways. A report of the projected trans-Alpine routes, with maps and information relating to them. 3800 w. Engr, Lond——March 9, 1906. Serial. 1st part. No. 75605 A.

PERMANENT WAY AND BUILDINGS.

Ash Handling.

Ash Handling Plants at Railway Ash Pits. Illustrates and describes the plant at McKees Rocks, Pa., near Pittsburg; and the Robertson ash-handling system at West Milwaukee, Wis. 1200 w. Eng News—March 22, 1906. No. 75650.

Ballast.

Ballasting. Abstract of report presented at meeting of the Am. Ry. Engng. & Main. of Way Assn., with discussion. 7300 w. Ry Age—March 23,, 1906. No. 75819.

Freight-Yards.

The Design of Yards for Classifying Freight Cars. W. A. MacCart. Considers some of the plans and methods of yard operation now in use and the efforts being made to develop some method to minimize the delay to freight traffic. 6500 w. Eng News—March 15, 1906. No. 75523.

Frogs.

Frogs Without Guard Rails. Illustrates and describes the Conley frog, which has as its especial feature the outer raised guard rails, bolted to the frog rails. Also the Graham frog, which has flange blocks or guards of Menard hardened steel bolted to the frog rails. 1000 w. Eng News—March 15, 1906. No. 75524.

Grades.

Grade Separation at Cleveland, Ohio. George H. Tinker. An illustrated description of work in progress and completed. 1500 w. R R Gaz—Vol. XL., No. 12. No. 75643.

Improvements.

Wabash Improvements East. Map and illustrated description of recent and current development and betterment of the Pittsburg Terminal and the Wheeling & Lake Erie lines. 3000 w. Ry Age—March 23, 1906. No. 75812.

Rail Joints.

See Street and Electric Railways.

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Rails.

Specifications for Steel Rails. Gives the specifications and recommendations adopted by the Am. Ry. Engng. and Main. of Way Assn., the Am. Soc for Test. Materials, and the Am. Soc. of Civ. Engrs. 2500 w. R R Gaz—Vol. XL., No. 11. No. 75551.

Reinforced Concrete.

The Use of Armoured Concrete in Railway Work in Russia. Serge de Kareischa. The first part contains particulars of the investigations made in Russia on the question of armoured concrete; and the second part describes in greater detail the methods adopted in the case of various constructive works. 13000 w. 17 tables. Ills. Bull Int Ry Cong—Feb., 1906. No. 75415 E.

Shops.

In the Railroad Shops. A. S. Atkinson. Calls attention to improvements recently observed in methods of arrangement, lighting, setting of machines, &c. 2300 w. Am Engr & R R Jour—March, 1906. No. 75314 C.

Ivorydole Shops, Cincinnati, Hamilton & Dayton Ry. Illustrated detailed description of terminal plant and repair shops. 3300 w. Ry & Engng Rev—March 3, 1906. No. 75347.

Some Small Successful Shop Savings. C. J. Crowley. A short paper on this subject, introducing a lengthy general discussion. 11000 w. Pro W Ry Club—Feb. 20, 1906. No. 75619 C.

The Electrical Equipment of the South Louisville Shops of the Lolisville & Nashville. Illustrates and describes interesting applications of the electric drive. 1000 w. R R Gaz—Vol. XL., No. 10. No. 75442.

The Missouri Pacific Shops at Sedalia, Mo. Illustrated detailed description of new shops. 4500 w. Ry Mas Mech—March, 1906. No. 75346.

Signals.

Signaling and Interlocking. Abstract of a report presented at meeting of the Amer. Ry. Engng. & Main. of Way Assn., with discussion. 9500 w. Ry Age—March 23, 1906. No. 75822.

Stations.

Santa Fe Standard Concrete Depots. Illustrates and describes some of these buildings, 21 of which are under contract. 1000 w. Ry Age—March 23, 1906. No. 75816.

The Washington Terminal Station. Theodore Starrett. An illustrated description of the concrete foundation work which has recently been completed on the new railroad building now in course of construction. 800 w. Cement Age—March, 1906. No. 75465.

Subways.

Reinforced-Concrete Subways on the Chicago, Burlington & Quincy Ry. Describes subways being constructed at Galesburg, Ill., in connection with a large classification yard. Ills. 2200 w. Eng Rec—March 10, 1906. No. 75478.

Switches.

A New French Pneumatic Interlocking Machine. Illustrated detailed description of a new design of machine being installed at numerous stations in France for interlocking switches and signals. 6000 w. Ry & Engng Rev—March 17, 1906. No. 75587.

Interlocking on the Lackawanna at Roseville. Illustrated description of a recently completed plant of 49 levers, at Newark, N. J., having special details of interest. 1200 w. R R Gaz—Vol. XL., No. 13. No. 75837.

Substituting Track Circuits for Detector Bars. W. N. Spangler. Read before the Ry. Sig. Assn. Calls attention to the features to be guarded against in electric lock signals, and the need of testing and inspection each day; urges the advantages of the track circuit over the detector bars. 2300 w. Ry & Engng Rev—March 24, 1906. No. 75677.

Switching.

Gravity Switching in Railway Yards. Explains the operation of the gravity system, referring to the Edge Hill yard, near Liverpool, England. 2500 w. Eng News—March 22, 1906. No. 75653.

Summit or Hump Yards for Gravity Switching. Abstract of the report of the Committee on Yards and Terminals, presented at meeting of the American Railway Engng. & Main. of Way Assn. 1200 w. Eng News—March 22, 1906. No. 75654.

Terminals.

East Altoona Engine Terminal of the Pennsylvania. Rodney Hitt. Illustrated description of a new terminal which handles more engines a day, probably, than any other engine terminal in the United States. 4500 w. R R Gaz—Vol. XL., No. 11. No. 75548.

The Atlantic Avenue Terminal of the Long Island Railroad. Illustrated description of this new terminal built in connection with the extensive improvements and electrification of this line. 3500 w. Eng Rec—March 3, 1906. No. 75402.

Yards and Terminals. Abstract of a report presented at meeting of the Am. Ry. Engng. & Main. of Way Assn., with discussion. 3800 w. Ry Age—March 23, 1906. No. 75820.

Third Track.

Lackawanna Third-Track Work at Scranton, Pennsylvania. Hugh Rankin. Explains the causes of congestion at Scranton, and the new third track to relieve the conditions. Many illustrations of interesting work. 2000 w. R R Gaz—Vol. XL., No. 11. No. 75549.

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Ties.

Steel Cross Ties. W. F. Miller. Presents illustrations of types that have attracted attention, giving descriptions and other information. Discussion. 5000 w. Pro Engrs' Soc of W. Penn—March, 1906. No. 75620 D.

Ties. Abstract of report presented at meeting of the Am. Ry. Engng & Main. of Way Assn., with discussion. 15800 w. Ry Age—March 23, 1906. No. 75818.

Ties—The Supply and Demand. Gives an outline of the sources of supply and an estimate of the number of ties required annually, with an account of efforts being made to provide for the future supply. 2500 w. R R Gaz—Vol. XL., No. 11. No. 75544.

Track.

Five Years of Heavy Track Construction (Fünf Jahre Starkstoss Oberbau). A. Haarmann. An account of the behaviour of a section of railway between Hasbergen and Osnabrück, comparing the behaviour of steel and wooden cross-ties. 5000 w. Glasers Aunalen—March 1, 1906. No. 75722 D.

Track Elevation.

Chicago & Western Indiana Track Elevation at Chicago. Illustrations and descriptive notes on the work done in 1905. Earlier work having been previously described. 1000 w. Ry Age—March 23, 1906. No. 75815.

Washout.

Colorado River Crevasse—Salton Sea—Southern Pacific Tracks. Official statement of the causes and results of the misfortunes in the irrigation project of Southern California. I. The Causes of the Flood and Results of Efforts to Stop It. C. R. Rockwood. II. How the Flood Affected the Southern Pacific Railway. C. H. Ellison. 5000 w. Ry Age—March 23, 1906. No. 75813.

TRAFFIC.

Rates.

Rate Making on the Trunk Lines. Abstract of an article by Prof. William Z. Ripley, in the Feb. issue of the *Quarterly Journal of Economics*. 2800 w. Ry. Age March 2, 1906. No. 75348.

Senator Foraker's Speech. Extracts from speech before the U. S. Senate in opposition to the Hepburn Bill. Considers it unworkable and unconstitutional. 6800 w. R R Gaz—Vol. XL., No. 10. No. 75443.

The Reform of Passenger Rates in Germany. Translated from *Zeitung des Vereins*. 4000 w. Bul Int Ry Cong—Feb. 1906. No. 75416 E.

Report.

Pennsylvania Railroad. Editorial review of the report of the last year and its evidence of remarkable prosperity. 4300 w. R R Gaz—Vol. XL., No. 10. No. 75440.

MISCELLANY.

American Railways.

The German Report on North American Railways. Balthasar H. Meyer. A review of the report of the engineers who visited the United States at the time of the Louisiana Purchase Exposition. The remarks are mostly confined to the comparisons and opinions brought out. 3500 w. Ry Age—March 9, 1906. No. 75472.

Avalanches.

Experiences with Landslide Protection in Austria (Ueber Erfahrungen im Lawinenverbau in Oesterreich). Vincenz Pollack. Data concerning the effectiveness of protection works in the Austrian Alps against avalanches, snow slides, and wind in various grades. Serial. Part I. 4000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—March 9, 1906. No. 75735 D.

Fighting the Avalanche. Describes the action of avalanches as seen on the Canadian Pacific Railway, and the defense works for keeping railway lines open, and of overcoming blockades. Ills. 1600 w. Ry & Loc Engng—March, 1906. No. 75486 C.

China.

The Railways of China (Les Chemins de Fer de Chine). A general account of recent railway work in China, with map of existing and projected lines. 2500 w. Génie Civil—Feb. 24, 1906. No. 75716 D.

Hindustan.

The Railways of Hindustan. (Die Eisenbahnen Vorderindiens). Dr. Blum & E. Giese. Describing especially the stations, terminal connections and operative methods of the principal railways of the peninsula; with map. Two articles. 7500 w. Zeitschr d Ver Deutscher Ing—Feb. 17, 24, 1906. No. 75700 each D.

STREET AND ELECTRIC RAILWAYS

Birmingham, Ala.

Recent Improvements in Birmingham, Ala. The present article gives an outline of the operations and properties of the Birmingham Railway, Light & Power Company. Ills. 2000 w. St Ry Jour—March 24, 1906. No. 75678 C.

Cable Traction.

The Electric Cable Road at Nancy (Le Funiculaire Electrique de Nancy). G.

We supply copies of these articles. See page 319.

E. Bernardet. Illustrating an inclined cable railway to the summit of a hill 229 metres high, near Nancy, France. The cable runs continuously, and the number of cars is varied to suit the traffic. 2000 w. 1 plate. Génie Civil—March 3, 1906. No. 75725 D.

Costs.

Cost of Electric Railway Power Production and Transmission in the State of Indiana. Albert S. Richey. Considers the average costs per unit of power on the Indiana interurban roads. 2500 w. Jour Worcester Poly Inst—March, 1906. No. 75614 C.

Electric Locomotives.

See Railway Engineering, Motive Power and Equipment.

Elevated Railroad.

See Civil Engineering, Construction.

Interurban.

Operating Features of the Dayton & Troy Railway. An illustrated description of methods adopted on a successful short line in Ohio. 4400 w. St. Ry Jour —March 10, 1906. No. 75481.

London.

Baker Street and Waterloo Railway. Illustrated detailed description of this recently completed tube railway, its equipment, rolling stock, traffic, prospects, finances, &c. 11000 w. Tram & Ry Wld —March 8, 1906. No. 75634 B.

The London County Council Tramway Power Station at Greenwich. Illustrated detailed description of this large modern generating station in course of erection. 2300 w. Engng—March 2, 1906. Serial. 1st part. No. 75508 A.

Manila.

The Manila Electric Railway. An illustrated article describing the modern public lighting and transportation system installed, and giving information of interest in regard to its construction and the native labor employed. 3000 w. Ry & Engng Rev—March 17, 1906. No. 75586.

Monorail.

The Behr Monorail System. Charles Edmund Tingley. Illustrated description of this system, which is under consideration for a line from the Interborough terminus at Flatbush and Atlantic avenues, Brooklyn, to Coney Island. 1600 w. Elec N Y—March 7, 1906. No. 75380.

Municipal Ownership.

See Industrial Economy.

Operation.

Electric Railway Engineering. William Cooper. Discusses the control of cars and trains operated by direct current. 3800 w. Elec Jour—March, 1906. No. 75627.

Puget Sound.

The Puget Sound Electric .Railway An illustrated description of its physical features, equipment, passenger and freight traffic, operating system and accounting. 4500 w. St Ry Rev—March 15, 1906. No. 75639 C.

Single-Phase.

Single-Phase Electric Equipment for the New York Terminal Division of the New York, New Haven & Hartford R. R. Brief illustrated description of the 11,000-volt single-phase electric locomotive for this road. 3000 w. Eng News —March 22, 1906. No. 75655.

Sleet.

Fighting Sleet on the L. & W. V. R. R. Brief illustrated account of the sleet-fighting equipment as an example of the methods considered best for the third-rail electric road between Scranton and Wilkesbarre, Pa. 1000 w. Ry & Engng Rev—March 10, 1906. No. 75474.

Stray Currents.

See Civil Engineering, Water Supply.

Substations.

Transforming and Distributing Substation at Montreal, Canada. J. A. Burnett. Illustrated detailed description of the Mentana Street substation and the general scheme of connecting up the apparatus in the station. 2200 w. Elec Rev, N Y—March 17, 1906. No. 75561.

Subway.

Building the Brooklyn Subway. George L Fowler. Describes the subway system that is being constructed to connect the Long Is. R. R. with the East River tunnels and the subway system of New York, explaining methods of execution, and some of the difficulties. Ills. 3300 w. R R Gaz—Vol. XL., No. 11. No. 75550.

Sweden.

Electric Traction on Swedish Railways. Reviews a recently published report on the question of utilizing the unused water power of Sweden for generating electric power for the railways. 800 w . Engng—March 9, 1906. No. 75598 A.

Train Dispatching.

Train Dispatching on the Rochester & Eastern Rapid Ry. W. R. W. Griffin. Describes the method adopted by this electric railway in New York State. 3000 w. St Ry Rev—March 15, 1906. No. 75640 C.

Welding Rail-Joints.

A New System of Electrically Welding Rail-Joints. Brief illustrated description of a method being employed in Germany. A high temperature is secured by the use of a large electric arc. 700 w. March 17, 1906. No. 75577 C.

We supply copies of these articles. See page 319.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer. *w.* Pittsburg.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.

Electric Journal. *m.* Pittsburg, Pa.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Magazine. *m.* Cambridge, Mass.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A
Locomotive. *m.* Hartford. U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U.S.A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal..
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pac. Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Instituts Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.